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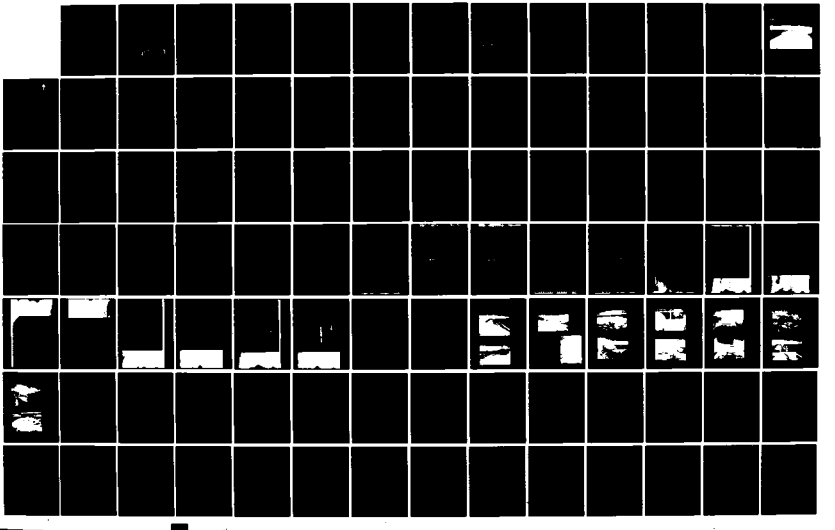
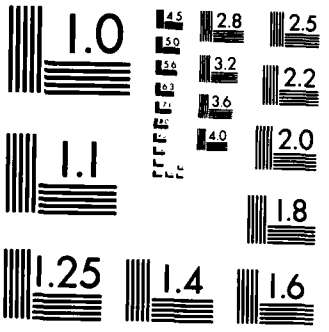


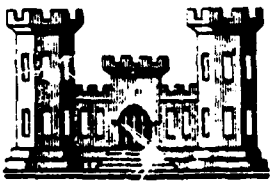


MERRIMACK RIVER BASIN
ASHLAND, MASSACHUSETTS

HOPKINTON RESERVOIR DAM

MA. 00437

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

JANUARY 1981

UNCLASSIFIED

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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
Ashland, Massachusetts
Indian Brook

20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is an earth embankment about 58 ft. high, 1525 ft. long and has a concrete core wall. The dam is intermediate in size and has a high hazard potential classification. The dam is judged to be in generally good condition. The owner should implement various operating and maintenance measures.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:

NEDED

JUN 12 1981

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Hopkinton Reservoir Dam (MA-00437) Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, Commonwealth of Massachusetts, Department of Environmental Management, 100 Nashua Street, Boston, Massachusetts.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely,

C. E. EDGAR, III
Colonel, Corps of Engineers
Commander and Division Engineer

Incl
As stated

HOPKINTON RESERVOIR DAM

MA 00437

MERRIMACK RIVER BASIN
ASHLAND, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	MA 00437
Name of Dam:	Hopkinton Reservoir Dam
Town:	Ashland
County and State:	Middlesex County, Massachusetts
Stream:	Indian Brook
Date of Inspection:	21 October 1980

BRIEF ASSESSMENT

Hopkinton Reservoir Dam, constructed in the 1890's, is an earth embankment about 58 ft. high, 1525 ft. long and has a concrete core wall. The upstream slope of the embankment is covered with hand placed granite riprap. A gravel and grass roadway is located along the 20 ft. wide crest. The downstream slope has a berm at about mid-height and is grass covered. There is a 12 acre swimming area at the downstream toe. There is a 29.8 ft. long broad crested spillway at the left abutment and two low level outlet facilities. The reservoir can be drawn down by release through a 48 in. dia. outlet pipe. The reservoir is used primarily for recreational purposes. It also recharges wells located on the south rim of the reservoir.

The reservoir is about 10,000 ft. long and the surface area of the pond at spillway crest is about 180 acres. The drainage area above the dam is about 6.28 sq. mi. (4,019 acre-ft.), the maximum storage to top of dam is about 6,848 acre-ft., and the height of the dam is about 58 ft. Based on height and storage, the size classification is intermediate. A breach of the dam would damage about one hundred fifty structures including residential, commercial and industrial establishments, eight bridges, one railroad, a pipeline, numerous roadways and potentially cause the loss of more than a few lives. Therefore, the dam has been classified as having a high hazard potential. Based upon the guidelines, the recommended test flood is a full PMF (9,600 cfs).

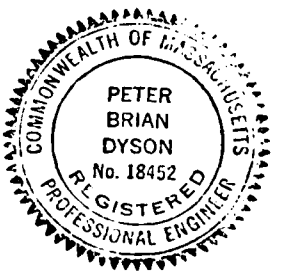
The routed test flow outflow (5,400 cfs) would overtop the dam by about 1 ft. The spillway will pass a ½ PMF flood with 0.5 ft. of freeboard.

The dam is judged to be in generally good condition. There is minor seepage at one location along the downstream toe. The left outlet structure is reported to be in working condition. The condition of the right outlet structure is unknown as it has not been operated in recent years.

Within two years after receipt of this Phase I Inspection Report, the owner, the State of Massachusetts, Department of Environmental Management, should retain the services of a registered professional engineer, experienced in the design of earth dams, and implement the results of his evaluation of the following: (1) supervise removal of trees including root systems from downstream slope of dam and backfill voids with suitable compacted material and, (2) repair the upstream controls for the 48 in. dia. outlet pipe on the left outlet structure.

The owner should also implement the following operating and maintenance measures: (1) repair voids in the riprap on the upstream slope of embankment by utilizing small stone sized to fit the individual voids; (2) repoint the masonry mortar joints on the right and left training walls of the spillway downstream of the spillway crest; (3) repoint the masonry wingwall at the discharge end of the 48-inch outlet pipe; (4) re-sod the erosion paths on the downstream slope of embankment in the vicinity of the 36-inch outlet structure; (5) monitor seepage at the downstream toe of embankment in the vicinity of the 48-inch outlet structure wingwall on a regular monthly basis; (6) institute an annual technical inspection program for the dam and appurtenant structures; (7) develop an "Emergency Action Plan" that will include an effective preplanned downstream warning system, locations of emergency equipment, materials and manpower, authorities to contact and potential areas that require evacuation. The plan will also include round-the-clock monitoring of the project during periods of heavy precipitation; (8) implement a regular periodic maintenance program; and (9) determine whether the right outlet structure is operative and if not study the feasibility of making any necessary repairs.

Peter B. Dyson
Project Manager



This Phase I Inspection Report on Hopkinton Reservoir Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

ARAMAST MAHTESIAN, CHAIRMAN
Geotechnical Engineering Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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APPENDIXES

HOPKINTON RESERVOIR DAM

OVERVIEW PHOTO

SECTION 5 - EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General

Hopkinton Reservoir Dam is a 1,525 ft. long, 58 ft. high earth embankment structure impounding an estimated normal storage of 4,500 acre-ft. with provisions for an additional 2,348 acre-ft. of capacity in it's surcharge space to top of dam. It is basically a high storage - low spillage facility used for recreational purposes and to charge municipal wells located on the rim of the reservoir. The spillway is capable of discharging about 1,820 cfs with the surcharge to top of dam. The general topographic characteristics of the 6.28 sq. mi. (4,019 acre) drainage basin is best described as rolling terrain, which rises from elevation 299 at spillway crest level to elevation 580. The drainage area is predominately forested and a large swamp occupies the central portion of the basin. It was reported by the owner's representative that, from the westerly drainage area, a pipe of unknown size drains into the Hopkinton Reservoir drainage area via Duck Pond. However, the inflow from this source was considered negligible for maximum flow computations.

5.2 Design Data

No hydrologic computations or hydraulic data have been recovered for the dam.

5.3 Experience Data

The only records available in regard to past operation of the reservoir are water levels. The records are kept at the Hopkinton State Park Headquarters. It appears that the majority of the time the reservoir level is below that of spillway crest level. It was reported by the operator of the dam that the dam has never been overtopped.

5.4 Test Flood Analysis

Hydrologic and hydraulic characteristics of Hopkinton Reservoir Dam and drainage area were evaluated in accordance with the criteria given in Recommended Guidelines for Safety Inspection of Dams. For determining surface areas and surcharge capacities, planimetered areas were taken from contours delineated on U.S.G.S. 1:24,000 quadrangle sheets. Reservoir area and capacity curves and tables for use in flood routing, are shown on Sheets D-2 and D-3, Appendix D.

As indicated in Section 1.2, paragraphs c and d, Hopkinton Reservoir Dam is classified as intermediate in size and has a high hazard potential. The recommended test flood for hydraulic evaluation of such a dam is a full Probable Maximum Flood, (PMF).

SECTION 4 - OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operation Procedures

a. General. The dam is owned and operated by the State of Massachusetts, Department of Environmental Management. It is operated as a recreational facility and also charges wells located on the south rim of the reservoir. These wells are owned and operated by the Town of Ashland and are used for domestic water supply purposes. In the winter Hopkinton Reservoir is generally drawn down about 6 ft. below the spillway crest elevation in order to provide storage for excess spring runoff.

b. Description of any Warning System in Effect. No warning system is in effect at Hopkinton Reservoir Dam. The dam is visted daily.

4.2 Maintenance Procedures

a. General. There is no documented regular periodic maintenance program in effect at Hopkinton Reservoir Dam. There are, however, several items which require and evidently receive periodic maintenance: the upkeep of the riprap on the upstream slope, the upkeep of sod on the crest and downstream slope of the dam and dike, the removal of debris from the spillway crest, the repair of the spillway training walls, the surveillance of the embankment seeps, and, the maintenance of the outlet structures and gates.

b. Operating Facilities. All outlet facilities except for the right low level outlet appear to be well maintained and are reported to be in operating condition.

4.3 Evaluation

Overall maintenance of the dam is generally good. Specific maintenance items are evaluated as follows: there are some voids in the upstream riprap, the sod on the crest and downstream slope of both the dam and dike is in good condition, trees are growing on the downstream slope near the left abutment, the crest of the spillway was free of debris, the spillway training walls are in good condition but need some repointing, there is seepage along the downstream toe of the dam at the outlet structure, and only one of the two outlet facilities is reported to be in operating condition. The owner should establish a formal downstream warning system for the dam in the event of an emergency.

3.2 Evaluation

In general, the visual inspection adequately revealed key characteristics of the dam as they may relate to its stability and integrity, permitting an assessment to be made of those features affecting the safety of the structure. Minor seepage was noted at one area along the downstream toe of the dam. Small trees are growing on the downstream embankment along the right spillway training wall. The crest and downstream slope of the dam are well maintained with only minor erosion.

The left outlet facility was reported to be in operating condition but leaking. The 48 in. dia. pipe is primarily controlled at the downstream toe and is therefore under pressure as it passes thru the earth embankment. The condition of the right outlet facility is unknown. The spillway training walls are in good condition but require some minor repointing of the joints as does the masonry headwall for the 48 in. dia. outlet pipe. There is no regular periodic maintenance program. For these reasons the dam was judged to be in good condition.

There are two low level outlets at Hopkinton Reservoir Dam. The larger of the two outlets is a 48 in. dia. cast iron pipe located about 340 ft. right of the left abutment. The invert of the 48 in. dia. pipe is located at the bottom of the reservoir. Discharge is controlled by a sluice gate located in a gate chamber that is operated from the crest of the dam. The gate is reported to be in operating condition but leaking. A second control for this outlet is a 36 in. dia. horizontal gate valve with a 6 in. dia. by-pass located near the downstream end of the pipe. Discharges through the 48 in. dia. pipe are controlled at this location. The 48 in. dia. outlet pipe discharges through a masonry headwall into a large swimming pool area operated by the State Park Service. The masonry headwall is in need of repointing. A tee in the 48 in. dia. pipe located upstream of the 36 in. gate valve also enables low level flows to be discharged into the spillway outlet channel via a smaller connecting pipe line. This outlet control gate is also reported to be in operating condition. A plan of the piping system is shown in Appendix B.

The smaller of the two low level outlets is a 36 in. dia. cast iron pipe with a 24 in. dia. stub on the downstream end. This pipe is located about 475 ft. left of the right abutment. It is controlled by a sluice gate located in a gate chamber that is operated from the crest of the dam and also has a second control near the downstream end which is a gate valve. The condition of these gates is unknown. The owners representatives did not recall the last time the gates were operated. The outlet invert elevation of the 36 in. pipe is approximately 5 ft. higher than the outlet invert-elevation of the 48 in. pipe. The elevation at the inlet end of this pipe is unknown. The 36 in. dia. pipe discharges into an earth ditch which leads to Indian Brook. (see Appendix C, Photo Nos. 11, 12, 13 & 14).

A 30 in. dia. diversion pipe leads from the 48 in. dia. outlet pipe to Sudbury Reservoir. The outflow controls are located in a brick gate chamber at the toe of the dam. This diversion pipe has not been used for at least 10 years and probably longer. Its condition is unknown.

d. Reservoir Area. The reservoir behind the dam is an impoundment of Indian Brook. The shoreline upstream of the dam is in excellent condition with no evidence of slides, movements or distress. A diversion pipe of unknown size carries excess runoff from the adjacent watershed along Whitehorse Brook to Hopkinton Reservoir.

e. Downstream Channel. The spillway discharges into Indian Brook which joins the Sudbury River at a point about 1.3 miles below the dam. Sudbury River flows through the Town of Ashland located about 2 miles downstream of the dam. There are numerous roadways crossing Indian Brook and Sudbury River and many residential and commercial properties are located along the water course.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

a. General. The visual inspection of Hopkinton Reservoir Dam took place on 21 October 1980. On that date the water level was about 5 ft. below the spillway crest. There was no evidence of any major problems, but there is minor seepage at one location downstream of the dam. The dam is judged to be in good physical condition.

b. Dam. Hopkinton Reservoir Dam, an impoundment of Indian Brook, consists of a dam, spillway and outlet facilities. It is operated as a recreational facility and also charges wells located on the south rim of the reservoir.

The dam is an earth embankment with a concrete core wall. It is about 1,525 ft. long, 58 ft. high and has a crest width of about 20 ft. A grass and gravel road, along the crest of the dam is in excellent condition with no evidence of erosion or settlement. The 2 horizontal to 1 vertical upstream slope is protected with hand placed granite block riprap. There is some evidence of minor spalling of the riprap blocks on the upstream slope. The downstream slope is grass covered and in good condition with the exception of some eroded footpath. There are also several small trees on the downstream slope of the embankment along the side of the right spillway training wall. At about mid-height of the downstream slope there is an 8 ft. wide berm. Above the berm the downstream slope is 2 horizontal to 1 vertical and below the berm it is 2½ horizontal to 1 vertical. The horizontal and vertical alignment of the embankment is very good (see Appendix C, Photo No's 1, 2, 3 and 4).

Minor seepage was noted approximately 100 ft. downstream of the toe of and about 50 ft. right of the 48 in. dia. outlet pipe headwall. The seepage was issuing from an area approximately 20 ft. by 30 ft. The total seepage was clear and estimated to be less than 1 gpm (see Appendix C, Photo No. 5).

c. Appurtenant Structures. The spillway for Hopkinton Reservoir Dam is located about 20 ft. right of the left abutment. It is a 29.8 ft. long broad crested granite block, gravity structure. Granite block training walls extend 7 ft. from the spillway crest to top of dam. The spillway crest and training walls are in good condition. The spillway discharges into a 400 ft. long stepped wasteway constructed of mortared granite blocks. The wasteway empties into a 150 ft. long granite block channel with vertical concrete walls and then into a trapezoidal earth embankment channel which eventually joins the original stream. The downstream spillway discharge channel is in generally good condition with the exception of mortar missing from joints. (see Appendix C, Photo Nos. 6,7,8,9 & 10).

SECTION 2 - ENGINEERING DATA

2.1 Design Data

The only data recovered concerning the design of the dam and appurtenances are the plans found in Appendix B. These plans indicate the dam was constructed by the Boston Water Works in the 1890's.

2.2 Construction Data

The only records or correspondence regarding construction of the dam that have been recovered are the plans in Appendix B which indicate W. Jackson and D. Fitzgerald were the City Engineer and Resident Engineer, respectively, during construction of the dam.

2.3 Operation Data

No records or correspondence regarding past operation of the dam have been recovered.

2.4 Evaluation of Data

a. Availability. Little engineering data is available. The basis of the information presented in this report is principally the visual observations of the inspection team.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgement.

c. Validity. The documents recovered appear to be valid and are not challenged.

(8) Cutoff - Corewall extends to bedrock.

(9) Grout curtain - Unknown

h. Diversion and Regulating Tunnel - Not applicable

i. Spillway

(1) Type - Broad crested, mortared granite block, gravity structure

(2) Length of weir - 29.8 ft.

(3) Crest elevation - 299.0

(4) Gates - None

(5) U/S Channel - Reservoir

(6) D/S Channel - Stepped, granite block wasteway transitions to rectangular concrete channel, to trapezoidal earth channel.

j. Regulating Outlet - Primary

(1) Invert - Elev. 249.0

(2) Size - 48 in. dia.

(3) Description - 48 in. dia. cast iron pipe

(4) Control Mechanism: Hand operated sluice gate upstream and 36 in. dia. gate valve downstream.

k. Regulating Outlet - Secondary

(1) Invert - Elev. 255.0 approximate

(2) Size - 36 in. dia.

(3) Description - 36 in. dia. cast iron pipe with 24 in. dia. stub on downstream end.

(4) Control Mechanism - Hand operated sluice gate upstream and gate valve downstream.

(3) Spillway crest pool - 10,000

(4) Top of dam - 13,500

(5) Test flood pool - 13,900

e. Storage (acre-feet)

(1) Normal pool - 4,500

(2) Flood control pool - Not applicable

(3) Spillway crest pool - 4,500

(4) Top of dam - 6,848

(5) Test flood pool - 7,300

f. Reservoir Surface (acres)

(1) Normal pool - 180

(2) Flood control pool - Not applicable

(3) Spillway crest - 180

(4) Top of dam - 506

(5) Test flood pool - 560

g. Dam

(1) Type - Earth fill

(2) Length - 1525 ft.

(3) Height - 58 ft.

(4) Top width - 20 ft.

(5) Side slopes - Downstream: 2 horizontal to 1 vertical from crest to 8 ft. wide berm near mid height, then 2½ horizontal to 1 vertical from berm to toe.

Upstream: 2 horizontal to 1 vertical with 6 ft. wide berm near 3/4 height point protected with riprap below berm and smooth granite blocks above terrace.

(6) Zoning - Earth fill with concrete corewall. Clay puddle upstream of corewall.

(7) Impervious Core - Centrally located concrete corewall.

(2) Maximum Known Flood at Damsite. No records are available of flood inflows into Hopkinton Reservoir or of spillway releases and surcharge heads during such inflows.

(3) Ungated Spillway Capacity at Top of Dam. The ungated spillway capacity at top of dam. elevation 306.0 is 1,820 cfs.

(4) Ungated Spillway Capacity at Test Flood Elevation. The ungated spillway capacity is 2,170 cfs at test flood elevation 306.85.

(5) Gated Spillway Capacity at Normal Pool Elevation. Not applicable

(6) Gated Spillway Capacity at Test Flood Elevation. Not applicable.

(7) Total Spillway Capacity at Test Flood Elevation. The total spillway capacity at test flood elevation 306.85 is the same as (4) above, 2,170 cfs.

(8) Total Project Discharge at Top of Dam. With the 48 in. dia. outlet pipe open the total project discharge at top of dam, elevation 306, would be about 2,180 cfs.

(9) Total Project Discharge at Test Flood Elevation. The total project discharge at test flood is 5,400 cfs at elevation 306.85.

c. Elevation (Ft. N.G.V.D.) All elevations relative to an assumed spillway crest elevation taken from U.S.G.S. topographic map.

(1) Streambed at toe of dam - $248^{\pm}$

(2) Bottom of cutoff - $206^{\pm}$

(3) Maximum tailwater - Unknown

(4) Recreation pool - 299.0

(5) Full flood control pool - Not applicable

(6) Spillway crest - 299.0

(7) Design surcharge (Original Design) - Unknown

(8) Top of dam - 306.0

(9) Test flood surcharge - 306.85

d. Reservoir (Length in Feet)

(1) Normal pool - 10,000

(2) Flood control pool - Not applicable

After the State of Massachusetts took over ownership of the dam, the spillway wasteway was modified at the downstream end. A new 150 ft. long concrete spillway outlet channel was constructed and a 24 in. dia. pipe and valve were installed allowing low level discharges to be directed into the new spillway outlet channel. These modifications were made when a recreational area, including a 12 acre swimming pool was constructed just below the dam.

i. Normal Operating Procedures. There are no written operating procedures for the facility. The only operating devices are gates and valves associated with the two low level outlets. It was reported the 36 in. outlet has not been used in recent years. The 48 in. outlet pipe is operated to control levels in the reservoir and to fill the swimming pool located below the dam. During the summer the operator maintains the reservoir at about spillway crest level. During the winter the reservoir level is maintained about 6 ft. below spillway crest level.

1.3 Pertinent Data

a. Drainage Area. The drainage area contributing to Hopkinton Reservoir encompasses a total of about 6.28 sq. mi. (4,019 acres), of which 180 acres are occupied by the reservoir. The longest circuitous stream course leading to the dam is about 4.73 miles long with an elevation difference of about 191 ft., or at a slope of about 40 ft. per mile. The drainage area has a length of about 4.2 miles and has an average width of about 1.5 miles. The basin consists of both open fields and forested areas and more than half the village of Hopkinton lies within the drainage area. However, the basin is predominately forested. A large swamp containing about 490 acres is located near the center of the drainage area and becomes an extension of the reservoir during periods of high surcharge. It was reported that there is a diversion to the drainage area from Whitehorse Brook which lies in the adjacent western watershed. It was further reported that one of the components of the diversion is a pipe of unknown size which leads to Duck Pond located at the westerly water divide of the Hopkinton Reservoir drainage area.

b. Discharge at Damsite.

(1) Outlet Works Conduits. There are two low level outlets for Hopkinton Reservoir. The smaller of the two is a 36 in. dia. pipe which has not been operated in recent years. The larger outlet is a 48 in. dia. pipe with an invert elevation of 249.0. This outlet discharges directly into a swimming pool area below the dam or into the spillway discharge channel via auxiliary pipe lines. If the 48 in. dia. outlet pipe were wide open when the reservoir water surface level was at top of dam and the pipe was discharging to the swimming pool area it is estimated the pipe would be capable of discharging about 360 cfs.

c. Size Classification. Hopkinton Reservoir Dam has a hydraulic height of about 58 ft. above downstream river level, and impounds a normal storage of about 4,500 acre-ft. to spillway crest level and a maximum of about 6,848 acre-ft. to top of dam. In accordance with the size and capacity criteria given in Recommended Guidelines for Safety Inspection of Dams, the project falls into the intermediate category on the basis of height and storage and is therefore classified accordingly. An intermediate size dam is greater than 40 ft. high and has a storage capacity greater than 1,000 ac.-ft. but less than 50,000 ac.-ft.

d. Hazard Classification. A breach failure analysis was performed for the dam. As a result of this analysis, in the area of initial impact it is estimated that more than 150 structures including residential, industrial, and commercial establishments will be flooded to depths ranging in general from 1 ft. to 8 ft.

The breach discharge which initially has a magnitude of 178,000 cfs will be reduced to about 100,000 cfs when the surge reaches the center of the Town of Ashland about 2.7 miles below the dam. In addition numerous bridges, roadways and a railroad will be flooded causing additional excessive economic losses. It is estimated that any flooding due to the prefailure conditions would be confined to flooding of local roadways.

In accordance with the Recommended Guidelines for Safety Inspection of Dams, Hopkinton Reservoir Dam has therefore been classified as having a high hazard potential, since failure of the dam would cause serious damage to homes, industries, commercial establishements, highways, and a railroad with the potential for the loss of more than a few lives.

e. Ownership. Hopkinton Reservoir Dam is owned by the State of Massachusetts, Department of Environmental Management. Old plans which were recovered indicate that the dam was originally owned by the Boston Water Works.

f. Operator. The operator of the dam is Mr. Charles Hopshier, Department of Environmental Management, Hopkinton State Park, P.O. Box 41, Hopkinton, MA 01748. Telephone: 617-435-4303.

g. Purpose of Dam. Hopkinton Reservoir Dam is part of the Hopkinton State Park. Recreational facilities are located on the north rim of the reservoir and just below the dam. The reservoir serves a dual purpose in that it charges wells which are located on the south rim of the reservoir and are owned by the Town of Ashland, MA. The wells are used for domestic water supply purposes.

h. Design and Construction History. As indicated by some of the plans exhibited in Appendix B, it is believed the dam was constructed in the 1890's by the Boston Water Works for water supply purposes. One of these plans indicated that Mr. William Jackson and Mr. Desmond Fitzgerald were the City Engineer and Resident Engineer respectively, at the time of construction of the dam.

The dam has a crest width of 20 ft. The usptream slope is 2 horizontal to 1 vertical. At a point about one-fourth down the slope there is a 6 ft. wide berm. Below the berm the slope is protected with rip-rap while above the berm it is protected with smooth faced granite blocks. On the downstream side of the embankment there is an 8 ft. wide berm located at about midheight. Above the berm the slope is 2 horizontal to 1 vertical and below the berm the slope is 2½ horizontal to 1 vertical. The downstream slope is covered with 2 in. of loam and has a grass cover.

(2) Spillway. The spillway for Hopkinton Reservoir Dam is located about 30 ft. right of the left abutment. It is a broad crested, granite block, gravity structure having a weir length of 29.8 ft. Seven ft. high granite block training walls extend from the spillway crest to the top of the dam. The spillway discharges into a stepped wasteway constructed of mortared granite blocks which extends about 400 ft. downstream to the toe of the dam where it abuts an 180 ft. long granite block channel with vertical concrete walls. This channel empties into a trapezoidal earth channel which later joins the original stream.

(3) Low Level Outlets. There are two low level outlets at Hopkinton Reservoir Dam. The larger of the two outlets is a 48 in. dia. cast iron pipe located about 340 ft. right of the left abutment. The invert of the 48 in. dia. pipe is located at the bottom of the reservoir,and the outlet is controlled by a sluice gate in a gate chamber operated from the crest of the dam. A second control for this outlet is a 36 in. horizontal gate valve with a 6 in. dia. by-pass located near the downstream end of the pipe. The 48 in. outlet pipe discharges into a large swimming pool area operated by the State Park Service. A tee in the 48 in. dia. pipe located upstream of the 36 in. gate valve also enables low level flows to be discharged into the spillway outlet channel via a smaller connecting pipe line. A plan of the piping system is shown in Appendix B.

The smaller of the two low level outlets is a 36 in. dia. cast iron pipe with a 24 in. dia. stub on the downstream end. The pipe is located about 475 ft. left of the right abutment. This outlet is also controlled by a sluice gate located in a gate chamber and is operated from the crest of the dam. A second control for the 36 in. dia. pipe is a gate valve located near the downstream end of the pipe just upstream of the outlet headwall. The outlet invert elevation of the 36 in. dia. pipe is approximately 5 ft. higher than the invert elevation of the 48 in. pipe. The elevation at the inlet end of this pipe is unknown. The 36 in. dia. pipe discharges into an earth ditch which leads to Indian Brook.

A 30 in. dia. water supply pipe leads from the 48 in. dia. outlet pipe to Sudbury Reservoir. The controls are located in a gate chamber at the downstream toe of the dam (see Appendix B, page B-12). This pipe is not being used.

PHASE I INSPECTION REPORT

HOPKINTON RESERVOIR DAM MA 00437

SECTION 1 - PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Louis Berger & Associates, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Louis Berger & Associates, Inc. under a letter of 30 September 1980 from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0043, Job Change No. 1 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

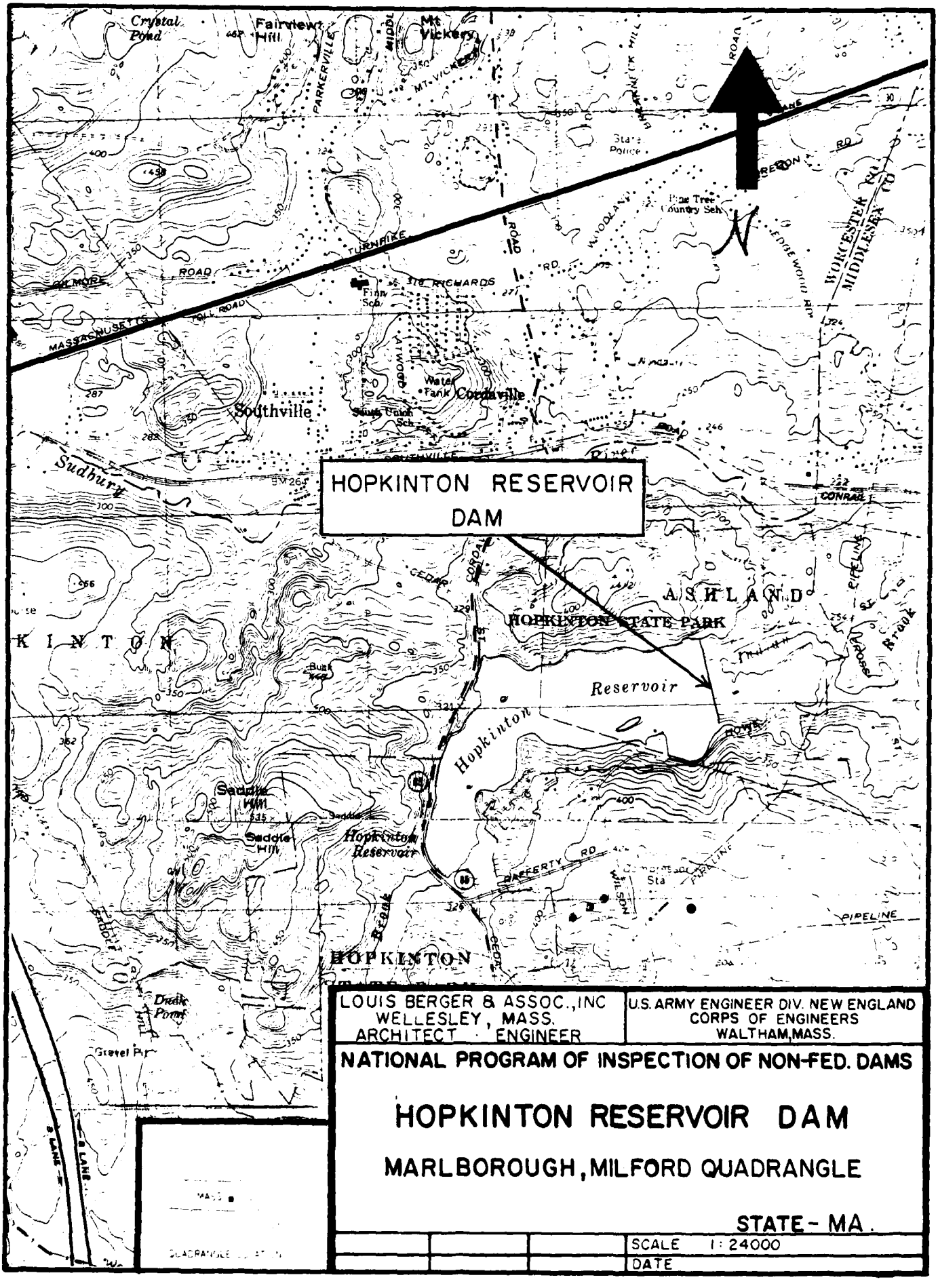
(3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Hopkinton Reservoir Dam is located in Middlesex County in the Town of Ashland in Eastern Massachusetts. The reservoir is situated on Indian Brook, which joins the Sudbury River at a point about 1.3 miles below the dam. The dam can be reached via a Hopkinton State Park Road off State Route 85 and is shown on U.S.G.S. Quadrangle, Marlborough Mass. with coordinates approximately at N 42° 15' 25", W 71° 30' 45".

b. Description of Dam and Appurtenances.

(1) Description of Dam. Hopkinton Reservoir Dam is an earth embankment structure about 58 ft. high and 1,525 ft. long. A large swimming pool is located at the downstream toe. The dam has a centrally located concrete core wall which according to original design plans extends upward from bedrock to within 3 ft. of the crest of the dam.



LOUIS BERGER & ASSOC., INC WELLESLEY, MASS. ARCHITECT ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

HOPKINTON RESERVOIR DAM

MARLBOROUGH, MILFORD QUADRANGLE

STATE - MA.

			SCALE 1:24000
			DATE

Precipitation data was obtained from Hydrometerological Report No. 51, which for this area of Massachusetts is 25.2 in. of 6 hour maximum rainfall over a 10 square mile area. This value was then reduced by 20 percent to allow for basin size, shape and fit factors; an additional 0.4 in. was deducted for infiltration losses. The six hour rainfall was distributed into one hour incremental periods as suggested in Corps of Engineers Publication EC 1110-2-1411.

A triangular incremental unitgraph was assumed for the inflow hydrograph using a computed lag time of 6.05 hours to derive a time-to-peak for the triangular hydrograph of 5.37 hours, (see computations on Sheets D-6 and D-7, Appendix D). The test flood hydrograph is shown on Sheets D-8, Appendix D, indicating a peak inflow of about 9,600 cfs or about a CSM value of 1,530.

Discharge tables and curves for the spillway and for over the top of the dam are shown on Sheets D-4 and D-5, Appendix D. Any discharges from the 36 in. and 48 in. dia. low level outlet pipes have been neglected.

Flood routings were performed for both the test flood and ½ PMF. Results of these routings are shown on Sheets D-9 thru D-14, Appendix D, and are summarized as follows:

Flood Magnitude	Test Flood Inflow (cfs)	Maximum Res. El. (ft.N.G.V.D.)	Max. Head Over Dam (ft.)	Maximum Freeboard (ft.)	Routed Test Flood Outflow (cfs)
PMF (Test Flood)	9,600	306.85	0.85	none	5,400
½PMF	4,800	305.5	none	0.5	1,630

From the above table, it can be seen that the project will not pass the routed test flood outflow without overtopping the dam by 0.85 ft. The spillway will pass a ½ PMF flood with 0.5 ft. of freeboard.

5.5 Dam Failure Analysis

A breach owing to structural failure of the dam by piping or sloughing is a possibility. For this analysis a breach was assumed to occur with the water level at top of dam. The "rule of thumb" method suggested in the New England Division Corps of Engineers March 1978 Guidance Report was used for the breach analysis. With a breach width of 20 percent of the dam length at mid height equal to 238 ft., an outflow of 178,000 cfs, which includes 1,820 cfs from the spillway, would be realized, (see Sheets D-15 thru D-24, Appendix D). Because of the relatively small spillway discharge, the downstream valley storage filled by the prefailure flow was not subtracted from available storage for attenuation of the dam-failure flow when routing the dam-failure flood.

The breach outflow from the reservoir will flow down Indian Brook for a distance of about 1.3 miles, thence along the Sudbury River for a distance of about 2.5 miles, causing excessive economic losses as it flows through the Village of Ashland, located about 2 miles downstream of the dam, until reaching reservoirs located downstream of Ashland.

It is estimated the Hopkinton State Park Recreation Pool located just below the dam and two local roadways will be severly damaged in the area immediately below the dam. In the next reach which extends from Ross Road to the Sudbury River, it is estimated one house will be flooded to a depth of 12 ft., four houses will be flooded to a depth ranging from 2 ft. to 6 ft., an industrial building will be flooded to a depth of 6 ft. The N.Y. Central Railroad line and a pipeline crossing the Brook will also suffer extensive damage in this reach. By the time the breach discharge reaches the Sudbury River it is estimated that its magnitude will be reduced to about 144,000 cfs. In the next reach which extends 4,800 ft. down the Sudbury River from Indian Brook it is estimated that about 25 houses and at least two commercial establishments will be flooded to depths ranging from 1 ft. to 8 ft. The next reach extends from just below Cordaville Road to a dam located just upstream of Myrtle Street which is located just about in the center of the Town of Ashland. It is estimated that about 68 houses and/or commercial establishments will be flooded to depths ranging from 1 ft. to 8 ft. in this reach. At the Myrtle Street Dam it is estimated the breach discharge will be about 100,000 cfs as it passes through the downtown area of Ashland. In the reach of the Sudbury River between Myrtle Street and the reservoirs located downstream of Ashland, flows in the channel are restricted by four bridge openings. Flows in the order of 100,000 cfs would inundate the area to depths similiar or greater than those estiamted for the area above Myrtle Street, causing extensive damage to homes and commercial and industrial establishments occupying the adjacent buildings. It is estimated that any flooding due to the prefailure conditions would be confined to flooding of local roadways and would in no way compare to the extensive flooding that would occur due to a breach of the dam.

In summary, in the area of initial impact, it is estimated that more than one hundred and fifty structures, including homes, industry and commercial establishments, eight bridges, one railroad, a pipeline and numerous roadways are within the area of potential flooding; there is also the potential for the loss of more than a few lives (see Sheet D-25, Appendix D). Therefore, in accordance with the Recommended Guidelines for Safety Inspection of Dams the dam has been classified as having a high hazard potential.

SECTION 6 - EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The Hopkinton Reservoir Dam is in good condition at the present time as revealed by the field inspection of October 21, 1980. There are several items of a remedial nature which were observed during the field visit and which will require treatment as outlined in Section 7. These are the seepage at the downstream toe, the small trees growing on the embankment along the side of the right spillway training wall and the minor erosion on the downstream slope.

6.2 Design and Construction Data

A complete set of plans of the embankment, spillway, and outlet structures is available and selected drawings are included in the appendix. However, data on construction of the embankments, including detailed laboratory soil test results, are not available. Calculations pertaining to the stability of the embankment and spillway are also unavailable.

6.3 Postconstruction Changes

There are no records of any major postconstruction changes made to the dam or spillway over the course of its history. However, there was some minor reconstruction consisting of new concrete training walls at the downstream end of the spillway outlet channel.

6.4 Seismic Stability

The dam is in seismic zone number 2 and, in accordance with recommended Phase I Guidelines, does not warrant seismic analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. On the basis of the Phase I visual examination, Hopkinton Reservoir Dam is judged to be in good condition. The deficiences reveal further investigations should be carried out and some remedial work is needed. The major concerns revealed by the Phase I investigations is the need to remove trees and to repair the upstream controls for the 48 in. dia. outlet pipe.

b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgement.

c. Urgency. The recommendations and remedial measures enumerated below should be implemented by the owner within two years after receipt of this Phase I Inspection Report.

7.2 Recommendations

It is recommended that the owner the State of Massachusetts, Department of Environmental Management should utilize the services of a competent registered professional engineer experienced in the design of earth dams for the following: (1) Supervise removal of trees including their root system from the downstream embankment and backfilling the voids with suitable compacted material. (2) Repair the upstream controls for the 48 in. dia. outlet pipe.

The owner should implement all recommendations by the Engineer.

7.3 Remedial Measures

a. Operation and Maintenance Procedures:

(1) Repair voids in the riprap on the upstream slope of embankment.

(2) Repoint the masonry mortar joints on the right and left training walls of the spillway downstream of the spillway crest.

(3) Repoint the masonry wingwall at the discharge end of the 48-inch outlet pipe.

(4) Re-sod the erosion paths on the downstream slope of embankment in the vicinity of the 36-inch outlet structure.

(5) Monitor seepage at the downstream toe of embankment in the vicinity of the 48-inch outlet structure wingwall on a regular monthly basis.

(6) Institute an annual technical inspection program for the dam and appurtenant structures.

(7) Develop an "Emergency Action Plan" that will include an effective preplanned downstream warning system, locations of emergency equipment, materials and manpower, authoritites to contact and potential areas that require evacuation. The plan will also include round-the-clock monitoring of the project during periods of heavy precipitation.

(8) Implement a regular periodic maintenance program.

(9) Determine if the right outlet structure is operative and if not study the feasibility of making any necessary repairs.

7.4 Alternatives

There appear to be no practical alternatives to the above recommendations.

Appendix A

Inspection Checklist

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Hopkinton Reservoir Dam DATE 21 October 1980

OWNER State of Mass. Dept.of Environmental Management TIME 9:30 AM

WEATHER Light Rain

W.S. ELEV. 294.0± U.S. NA DN.S.

INSPECTION PARTY

A/E REPRESENTATIVES

1. Pasquale E. Corsetti
2. Roger F. Berry
3. Carl J. Hoffman
4. William S. Zoino
5.

PROJECT FEATURE	INSPECTED BY	REMARKS
1. Hydrology	Roger F. Berry	LBA
2. Hydraulics/Structures	Carl Hoffman	LBA
3. Geotechnics	William S. Zoino	GZA
4. General Features	Pasquale E. Corsetti	LBA
5.		
6.		
7.		
8.		
9.		
10.		

LBA - Louis Berger & Associates, Inc.
GZA - Golberg-Zoino & Associates, Inc.

PERIODIC INSPECTION CHECKLIST

PROJECT Hopkinton Reservoir Dam DATE 10/21/80

PROJECT FEATURE Embankment NAME W. S. Zoino

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITIONS
DIKE EMBANKMENT	
Crest Elevation	299
Current Pool Elevation	294
Maximum Impoundment to Date	Unknown
Surface Cracks	None
Pavement Condition	N/A
Movement or Settlement of Crest	None
Lateral Movement	None
Vertical Alignment	Excellent
Horizontal Alignment	Excellent
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	None
Trespassing on Slopes	2 minor paths on downstream slope of embankment opposite right outlet structure
Sloughing or Erosion of Slopes or Abutments	None
Rock Slop Protection - Riprap Failures	Good, minor voids
Unusual Movement or Cracking at or near Toes	None
Unusual Embankment or Downstream Seepage	Minor seepage about 50 ft. right of outlet end of left outlet structure 1 gpm±
Piping or Boils	None
Foundation Drainage Features	Unknown
Toe Drains	Unknown
Instrumentation System	Unknown

PERIODIC INSPECTION CHECKLIST

PROJECT Hopkinton Reservoir Dam DATE 21 October 1980

PROJECT FEATURE Outlet Structures NAME C. Hoffman

DISCIPLINE Structures NAME

AREA EVALUATED	CONDITIONS	
OUTLET WORKS - CONTROL TOWER	Left Structure	Right Structure
a. Concrete and Structural		
General Condition	good	goood
Condition of Joints	good	good
Spalling	minor	minor
Visible Reinforcing	none	none
Rusting or Staning of Concrete	minor	minor
Any Seepage or Efflorescence	none	none
Joint Alignment	good	good
Unusual Seepage or Leaks in Gate Chamber	none	none
Cracks	none	none
Rusting or Corrosion of Steel	none	none
b. Mechanical and Electrical		
Air Vents	N/A	N/A
Float Wells	"	"
Crane Hoist	"	"
Elevator	"	"
Hydraulic System	"	"
Service Gates	"	"
Emergency Gates	"	"
Lightning Protection System	"	"
Emergency Power System	"	"
Wiring and Lighting System in Gate Chamber	"	"

PERIODIC INSPECTION CHECKLIST

PROJECT Hopkinton Reservoir Dam DATE 21 October 1980

PROJECT FEATURE Spillway NAME C. Hoffman

DISCIPLINE Structures NAME

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	good
Loose Rock Overhanging Channel	none
Trees Overhanging Channel	none
Floor of Approach Channel	granite block pavers good condition
b. Weir and Training Walls	
General Condition of Concrete	good
Rust or Staining	minor
Spalling	minor
Any Visible Reinforcing	none
Any Seepage or Efflorescence	minor
Drain Holes	none
c. Discharge Channel	
General Condition	good
Loose Rock Overhanging Channel	none
Trees Overhanging Channel	yes
Floor of Channel	granite block pavers
Other Obstructions	none

mortar missing from joints of downstream spillway training walls.

PERIODIC INSPECTION CHECKLIST

PROJECT Hopkinton Reservoir Dam DATE 21 October 1981

PROJECT FEATURE Service Bridge NAME C. Hoffman

DISCIPLINE Structures NAME

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SERVICE BRIDGE	
a. Superstructure	
Bearings	N/A
Anchor Bolts	N/A
Bridge Seat	N/A
Longitudinal Members	Good
Underside of Deck	Good
Secondary Bracing	N/A
Deck	Good
Drainage System	N/A
Railings	Yes
Expansion Joints	N/A
Paint	recently painted
b. Abutment & Piers	
General Condition of Concrete	Good
Alignment of Abutment	Good
Approach to Bridge	Good
Condition of Seat and Backwall	Good

PERIODIC INSPECTION CHECKLIST

PROJECT Hopkinton Reservoir Dam DATE 21 October 1980

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITIONS
Outlet Works - Intake Channel and Structure	N/A
Outlet Works - Transition and Conduit	N/A

Appendix B

Engineering Data

INSPECTION REPORT - DAMS AND RESERVOIRS

Location: ~~City~~/Town ASHLAND Dam No. 4-9-14-2

Name of Dam HOPKINTON RESERVOIR DAM Inspected by A.Z. PIZANO + F.H. PARE

Date of Inspection 8-28-73

Owners: por: Assessors ✓ Prev. Inspection _____

Reg. of Deeds _____ Pers. Contact _____

1 DEPT. OF NAT RES. DIV OF FORESTS + PARKS 100 CAMBRIDGE ST. 727-3180
Name St. & No. ~~City~~/Town State Tel. No.
BOSTON, MASS. - 02114

2 _____
Name St. & No. City/Town State Tel. No.

3 _____
Name St. & No. City/Town State Tel. No

Caretaker: (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

SAME
Name St. & No. City/Town State Tel. N

No. of Pictures Taken NONE

Degree of Hazard: (If dam should fail completely)*

1. Minor _____ 2. Moderate _____

3. Severe ✓ 4. Disastrous _____

*This rating may change as land use changes (future development)

Outlet Control: Automatic _____ Manual ✓

Operative ✓ yes: _____ no.

Comments: _____

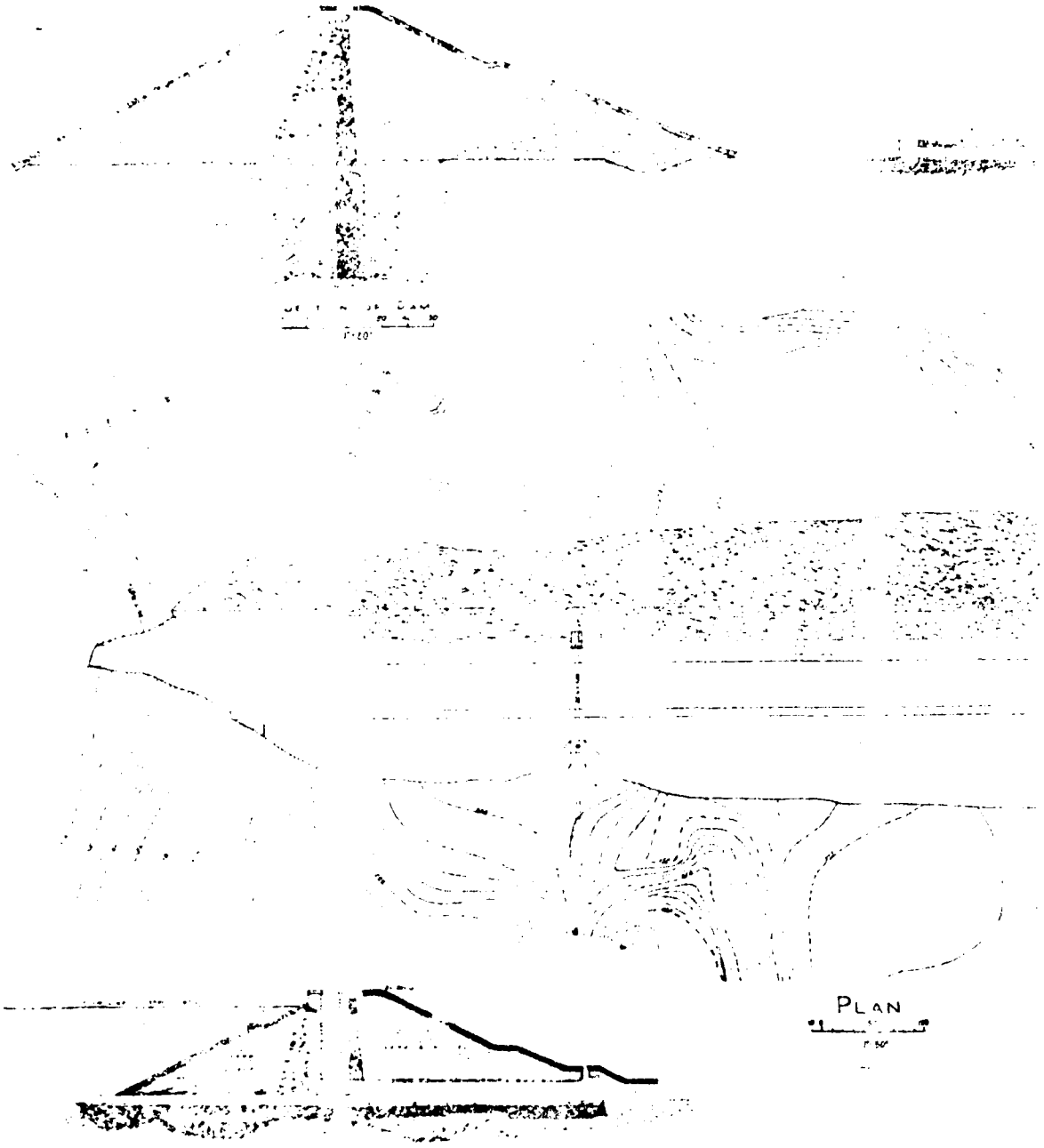
Upstream face of Dam: Condition:

1. Good ✓ 2. Minor Repairs _____

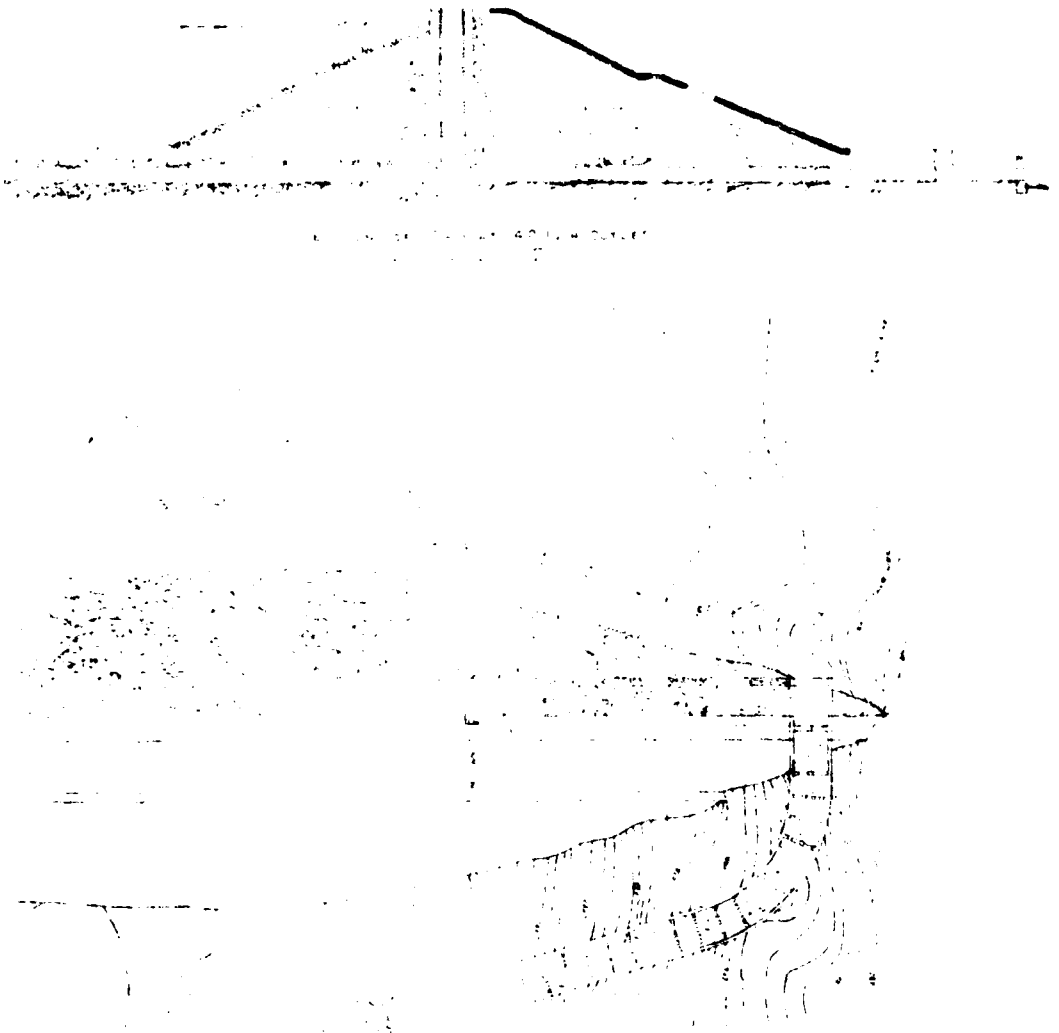
3. Major Repairs _____ 4. Urgent Repairs _____

Comments: _____

B-1



SECTION OF DAM AT 36 INCH OUTLET



BOSTON WATER WORKS

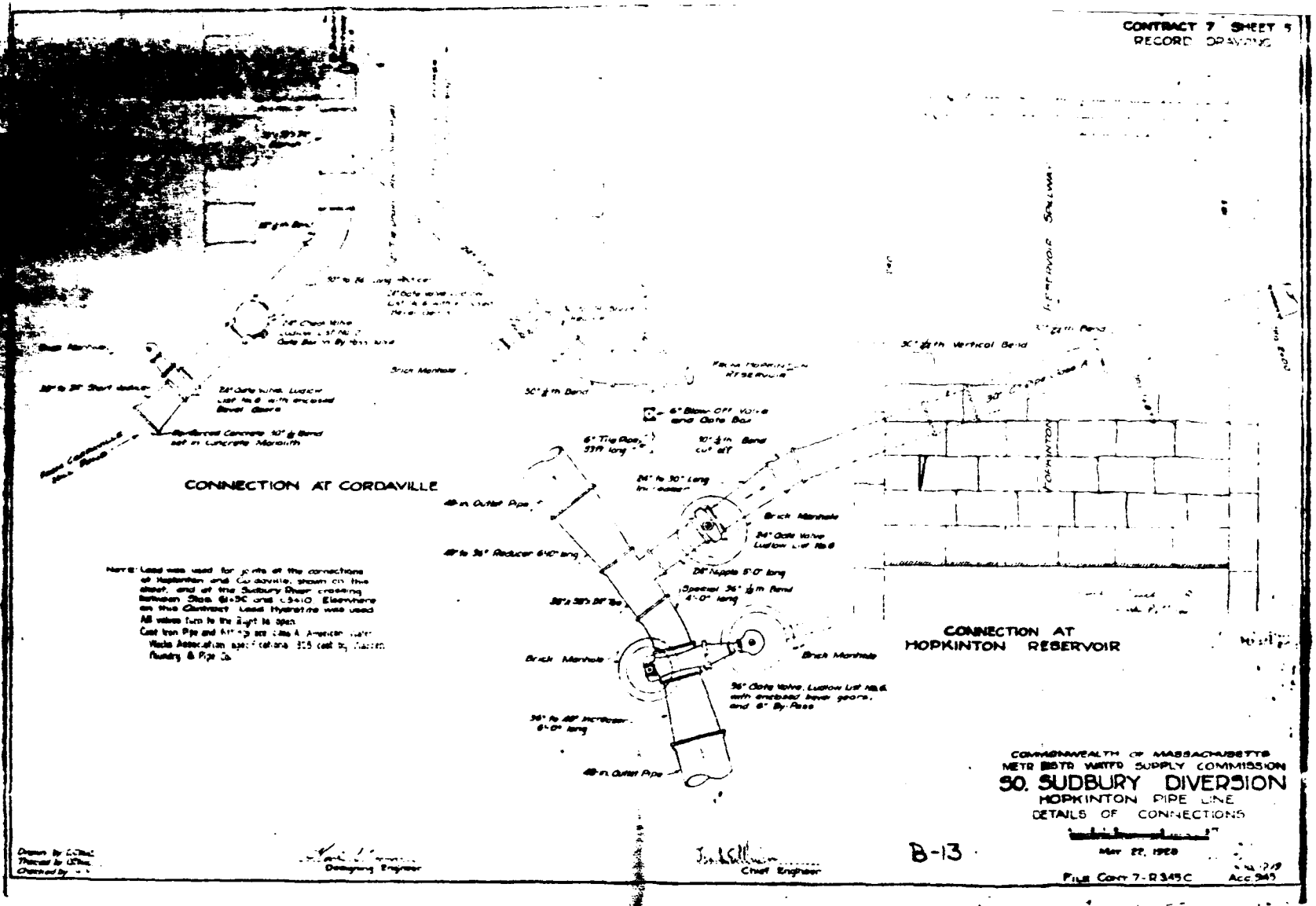
BASIN No 6

ASHLAND

GENERAL PLAN OF DAM

B-14

CONTRACT 7 SHEET 9
RECORD DRAWING



Here Lead was used for joints at the connections at Hopkinton and Cordaville, shown on this sheet, and at the Sudbury River crossing Elevation Stas. 61+30 and 63+10. Elsewhere on this Contract Lead Substitute was used.
All valves Turn to the Right to open.
Cast Iron Pipe and Fittings are to A. American Water Works Association specifications 315 cast by Eastern Foundry & Pipe Co.

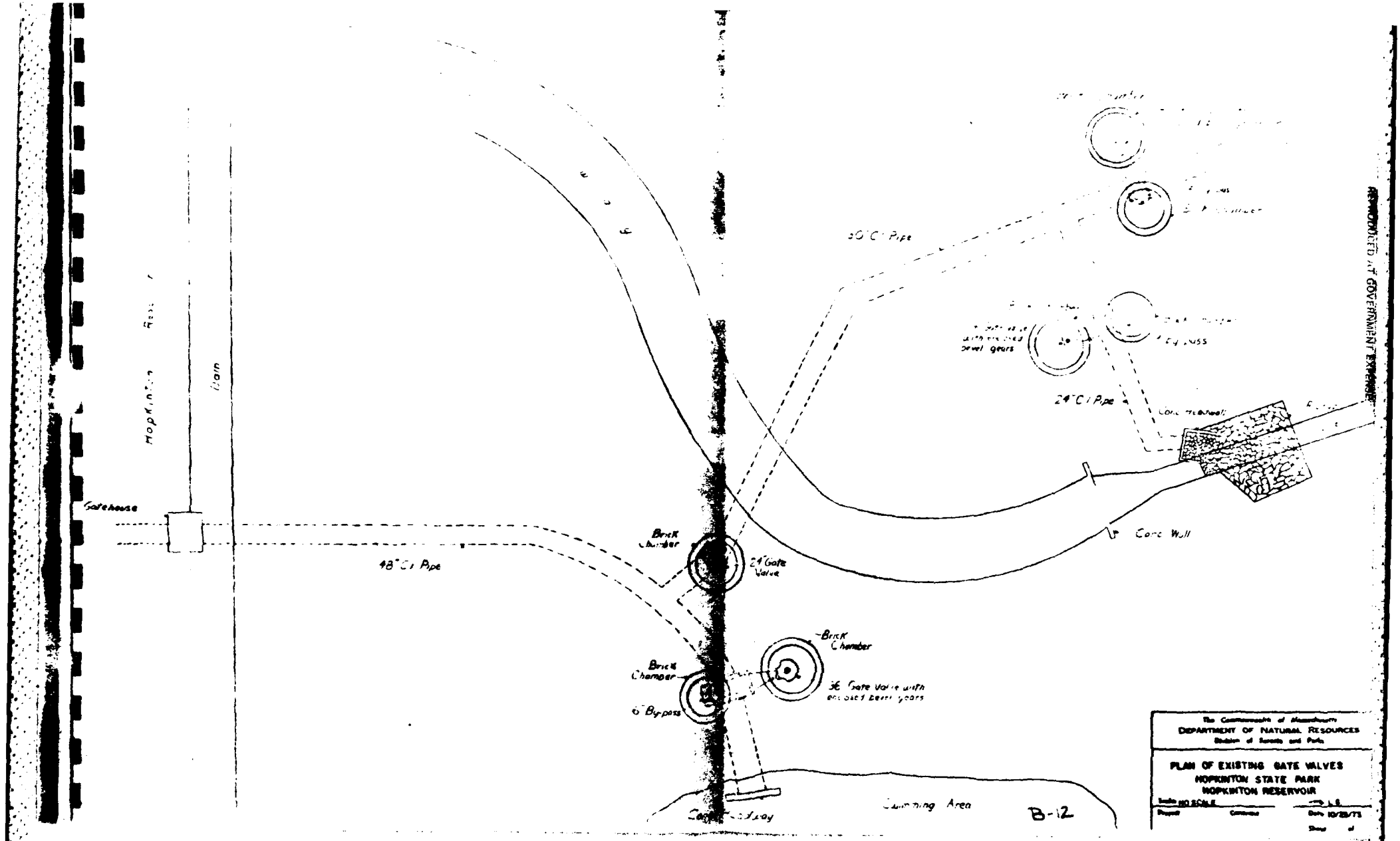
Drawn by C.C.M.
Traced by L.D.M.
Checked by

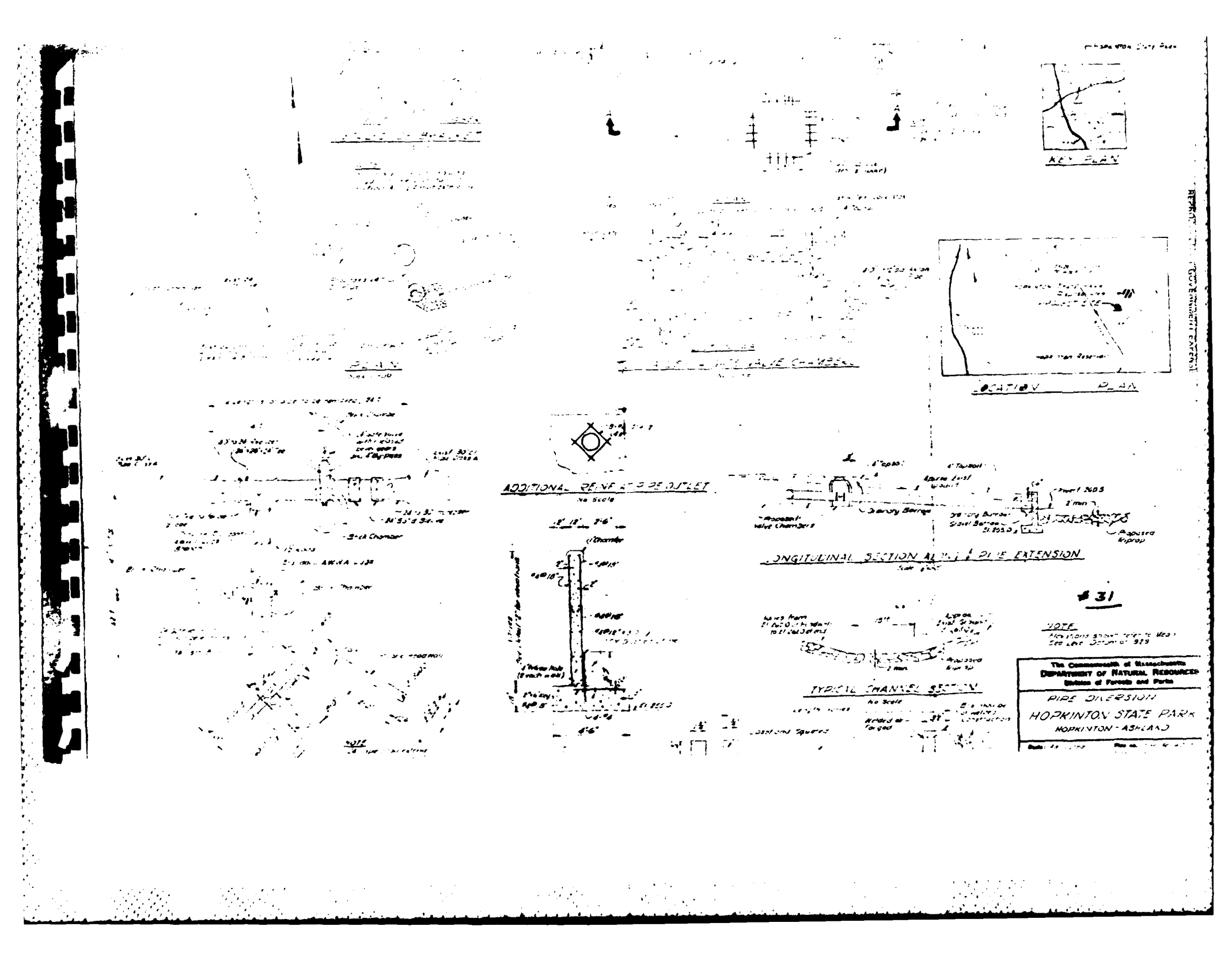
Designing Engineer

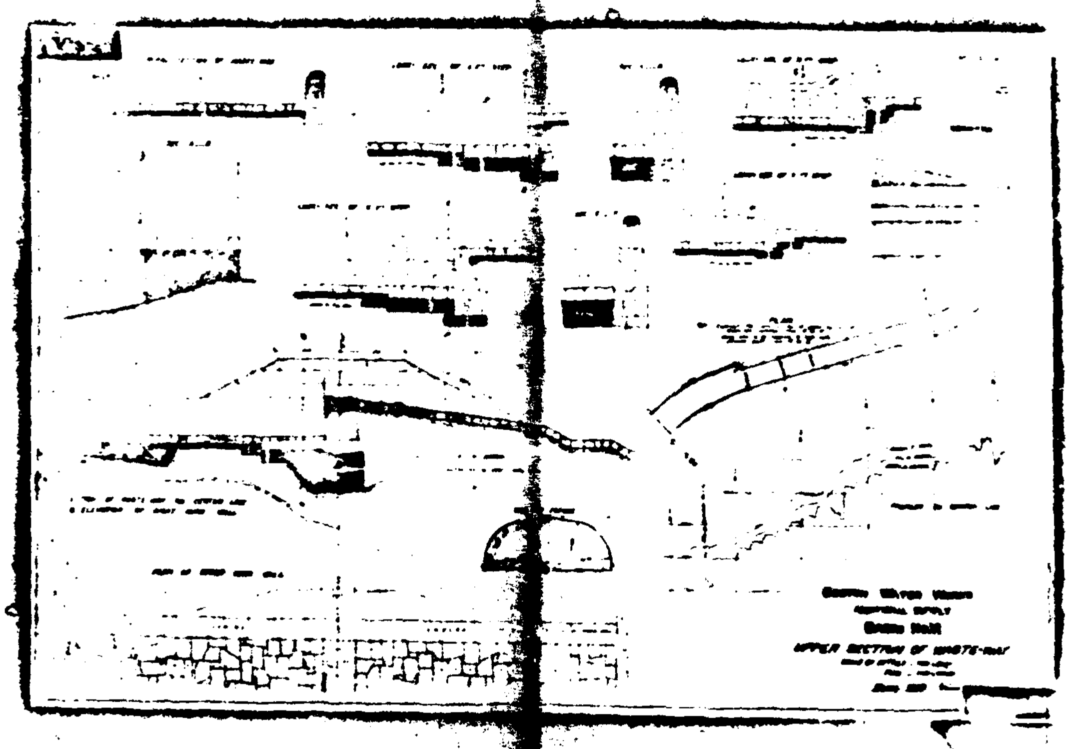
Chief Engineer

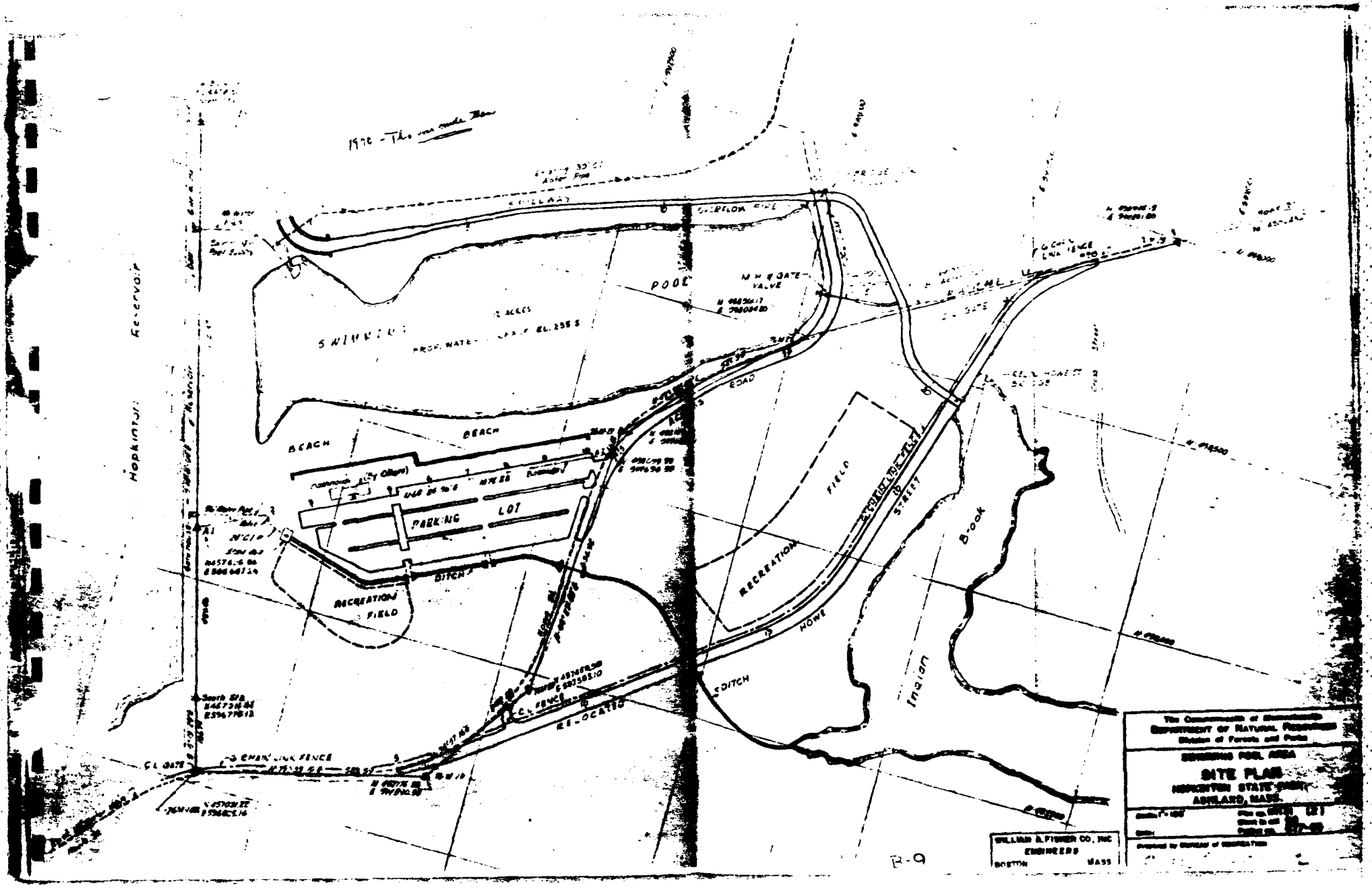
B-13

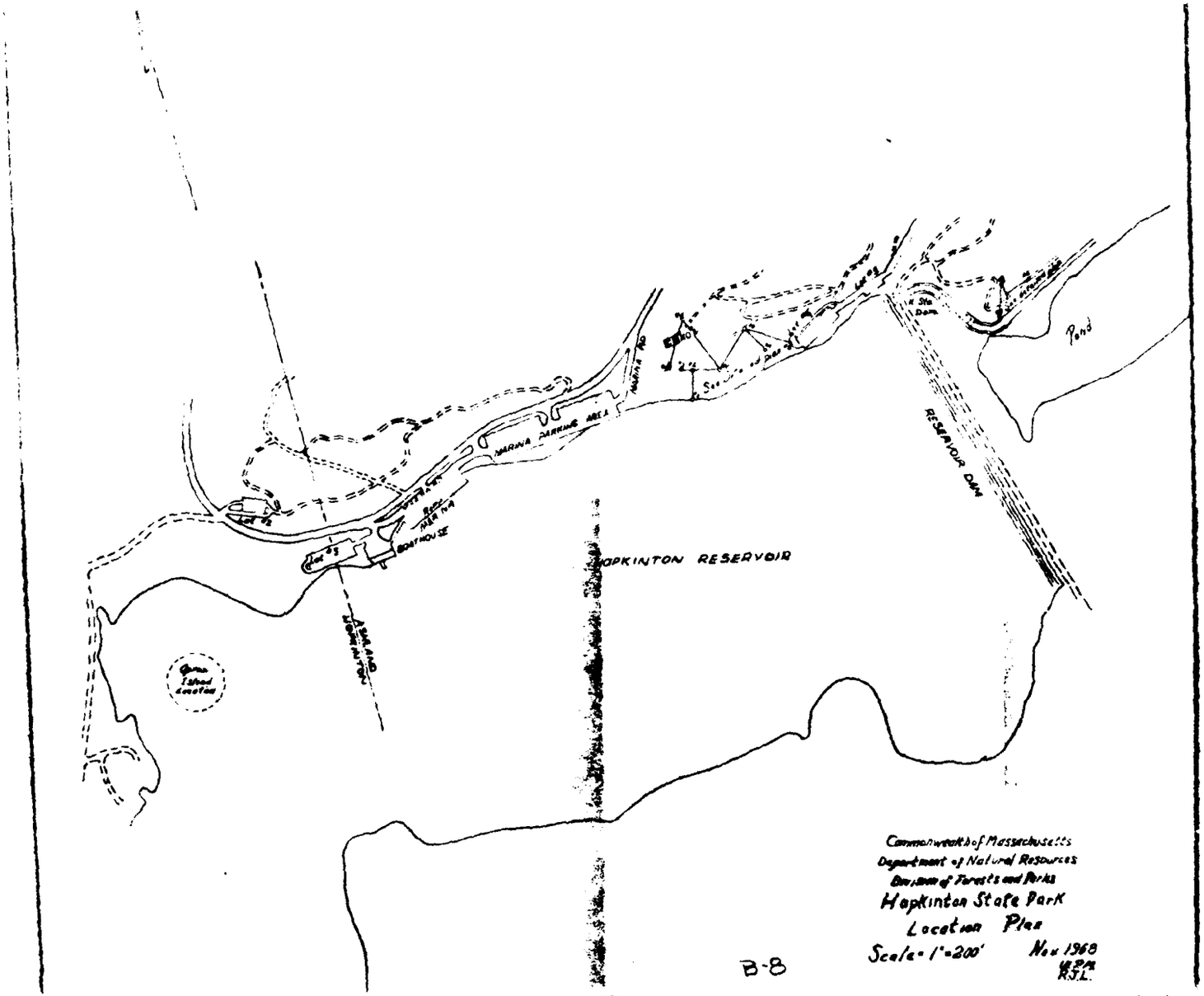
COMMONWEALTH OF MASSACHUSETTS
METROPOLITAN WATER SUPPLY COMMISSION
50. SUDBURY DIVERSION
HOPKINTON PIPE LINE
DETAILS OF CONNECTIONS
Scale 1" = 10'
May 22, 1928
File Cont 7-R345C
Acc 345

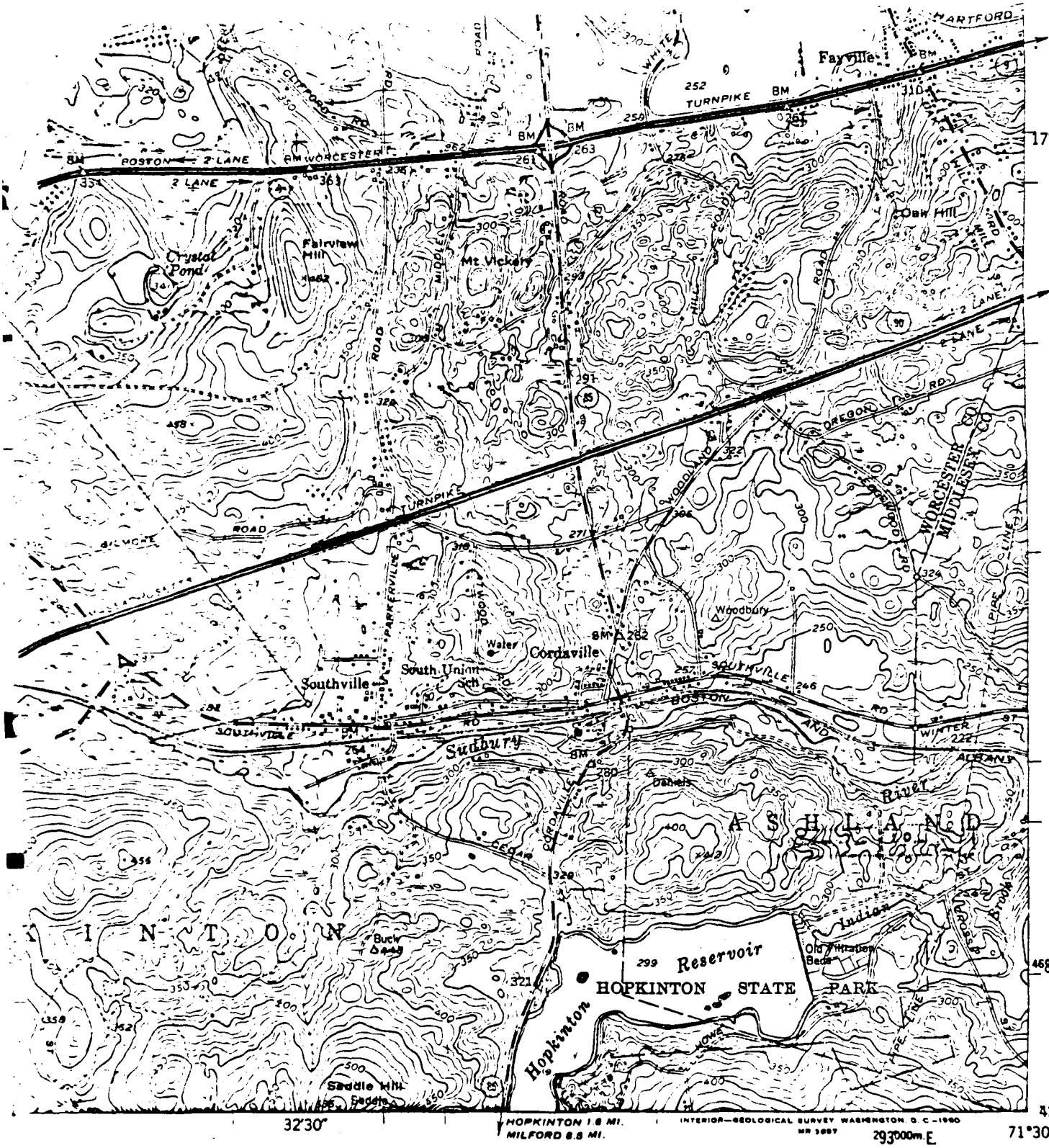

Gatehouse
48" C.I. Pipe
Brick Chamber
24" Gate Valve
Brick Chamber
Brick Chamber
6" By-pass
36" Gate Valve with enclosed bevel gears
30" C.I. Pipe
24" C.I. Pipe
Conc. Wall
Swimming Area
B-12
The Commonwealth of Massachusetts
DEPARTMENT OF NATURAL RESOURCES
Division of Forests and Parks
PLAN OF EXISTING GATE VALVES
HOPKINTON STATE PARK
HOPKINTON RESERVOIR


KEY PLAN
LOCATION PLAN
ADDITIONAL RIPRAP OUTLET
No Scale
LONGITUDINAL SECTION ALONG PIPE EXTENSION
TYPICAL CHANNEL SECTION
No Scale
#31
NOTE
PIPE DIVERSION
HOPKINTON STATE PARK
HOPKINTON - ASHLAND


UPPER SECTION OF WASTE-WAY


1970 - The one under Plan
Hopkinton Reservoir
POOL
BEACH
BEACH
PARKING LOT
RECREATION FIELD
RECREATION FIELD
BALL FIELD
Indian Brook
HOWE STREET
EDAD
DITCH
DITCH
CHAIN LINK FENCE
CHAIN LINK FENCE
GATE
GATE
MH & GATE VALVE
SWIMMING
R-9
WILLIAM A. FISHER CO., INC
ENGINEERS
BOSTON
MASS
SWIMMING POOL AREA
SITE PLAN
HOPKINTON STATE PARK
ASHLAND, MASS.


MARINA PARKING AREA
RESERVOIR DAM
Pond
HOPKINTON RESERVOIR
Commonwealth of Massachusetts
Department of Natural Resources
Division of Forests and Parks
Hopkinton State Park
Location Plan
Scale 1"=200'
May 1968
WEPA
R.S.L.
B-8



ROAD CLASSIFICATION

Heavy-duty ——— Light-duty — — —

Medium-duty ——— Unimproved dirt .....

Interstate Route U S Route State Route

1 MILE

5000 6000 7000 FEET

KILOMETER

MASS

QUADRANGLE LOCATION

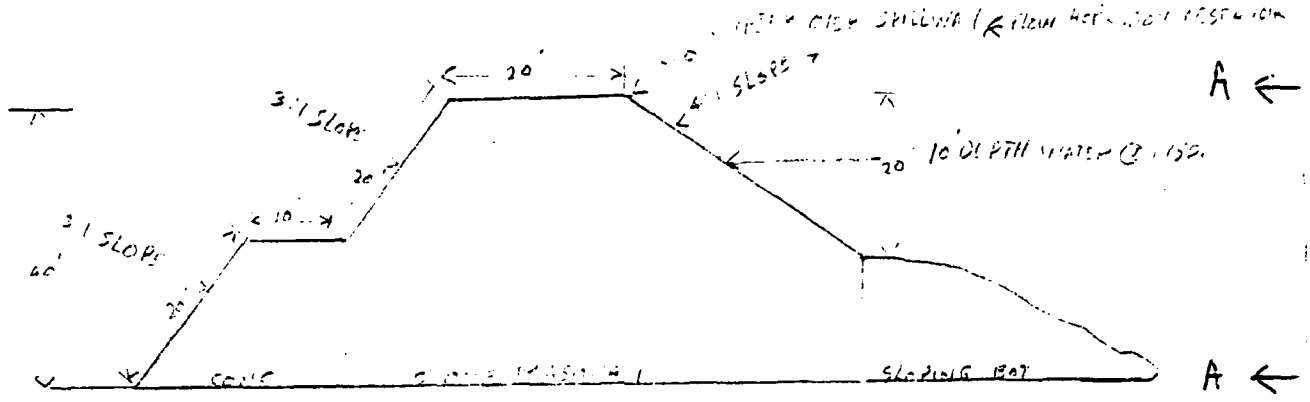
MARLBORO, MASS.

N4215—W7130/7.5

RACY STANDARDS

SHINGTON 25, D. C.

4-9-14:2



X SECTION A A

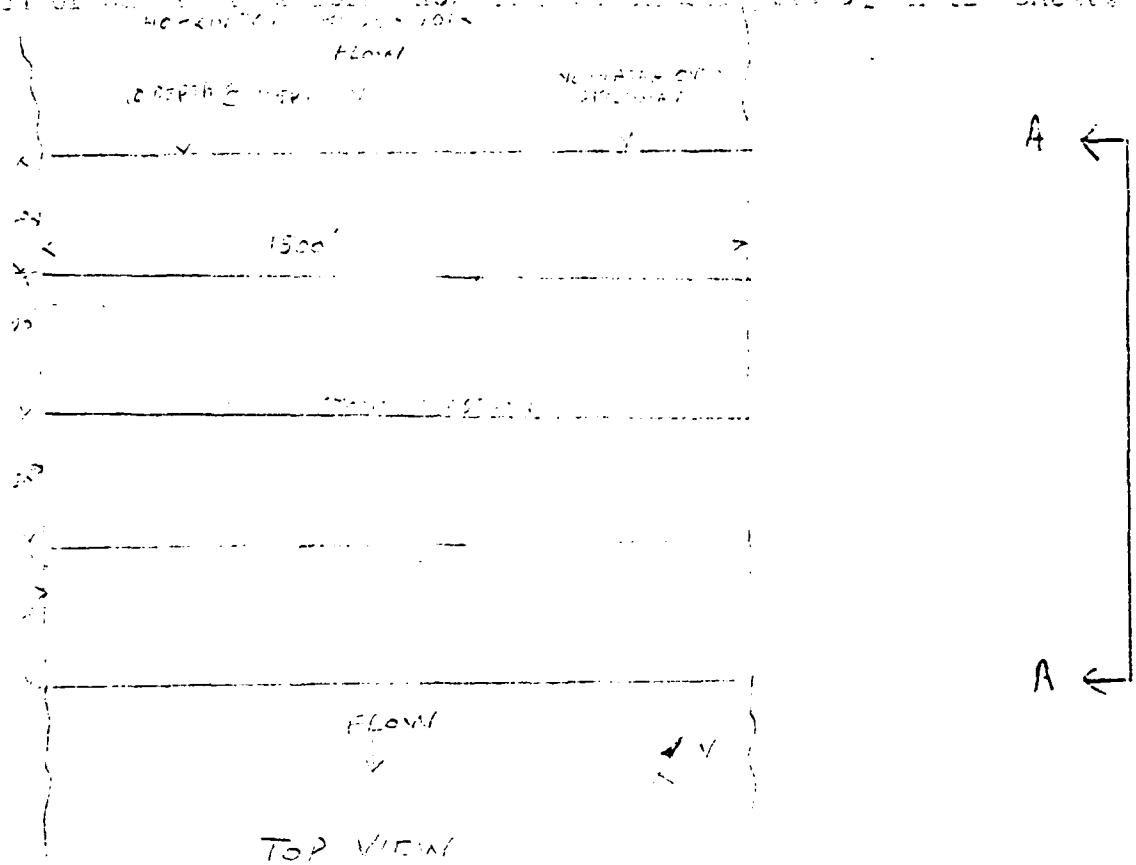
SKETCH NOT TO SCALE

DAM NO. 4-9-14-2

10. Risk to life and property in event of complete failure.

No. of people EST 30, 3 PERSONS PER HOME
No. of homes 10
No. of businesses NONE
No. of industries _____ Type _____
No. of utilities NORTH-EAST Type GAS PIPE LINE ¼ MILE DOWNSTREAM
Railroads NY CENTRAL ½ MILE DOWNSTREAM, OPERATING
Other dams ¼ OF A MILE DOWNSTREAM, 4-9-14-3
Other _____

11. Attach Sketch of dam & its appurtenances and flow diagram. Use 8½" x 11" Sheets.



DESCRIPTION OF DAM
DISTRICT #4

Submitted by FRANCIS W. PARÉ & ADAM Z. PIZAN Dam No. 4-9-14-2
Date 2-28-73 ~~City~~ Town ASHLAND CITY
Name of Dam HOPKINTON RESERVOIR DAM

1. Location: Topo Sheet No. 230
Provide 8½" x 11" in clear copy of topo map with location of Dam clearly indicated.

2. Year built: UNKNOWN Year/s of subsequent repairs UNKNOWN

3. Purpose of Dam: Water Supply ✓ Recreational ____
Irrigation ____ Other ____

4. Drainage Area: 6 SQ. MI. 3840 ACRES.

5. Normal Ponding Area: 150 acres; Ave. Depth 10'
Impoundment: 500 MIL gals; 1,520 acre ft.

6. No. and type of dwellings located adjacent to pond or reservoir i.e. summer homes etc. 2 PERMANENT BLD STATE FOREST FACILITIES

7. Dimensions of Dam: Length 1500 Max. Height 40
Slopes: Upstream Face 4:1
Downstream Face 3:1
Width across top 20

8. Classification of Dam by Material:
Earth ____ Conc. Masonry ✓ Stone Masonry ✓
Timber ____ Rockfill ____ Other ____

9. [illegible] of present land usage downstream of dam: 95 % rural; 5 % urban.

10. [illegible]

B-4

DAM NO. 4-9-14-2

(12.) Remarks & Recommendations: (Fully Explain)

DAM IS IN GOOD CONDITION, AND WELL PRESERVED.

(13.) General Condition:

1. Date ✓

2. When was it inspected

3. Condition: Fair, Safe, Major repairs needed

4. Name

5. Remarks & recommendations by inspecting engineer (Explain)

Recommend renewal of inspection (at

DAM NO. 4-9-14-2

(8) Downstream Face of Dam: Condition: 1. Good ✓ 2 Minor Repairs____

3. Major Repairs____ Urgent Repairs__

Comments:_____

(9) Emergency Spillway: Condition: 1. Good ✓ 2. Minor Repairs____

3. Major Repairs____ 4. Urgent Repairs____

Comments:_____

(10) Water level @ time of inspection ____ ft. above____ below 10'

top of dam ✓ Principal spillway____

other____

(11) Summary of Deficiencies Noted:

Growth (Trees and Brush on Embankment____

Animal Burrows and Washouts____

Damage to slopes or top of dam____

Cracked or Damaged Masonry____

Evidence of Seepage____

Evidence of Piping____

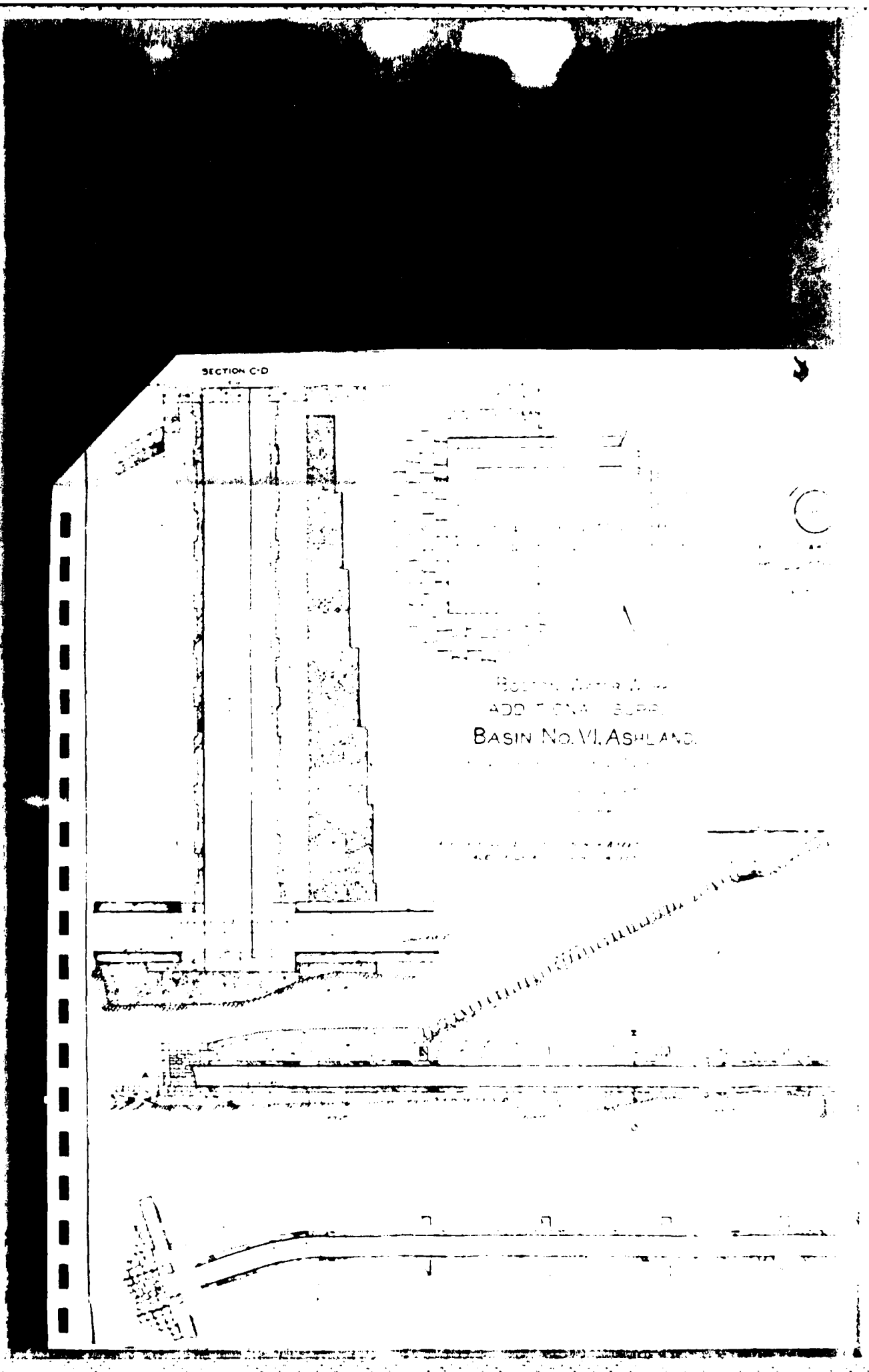
Erosion____

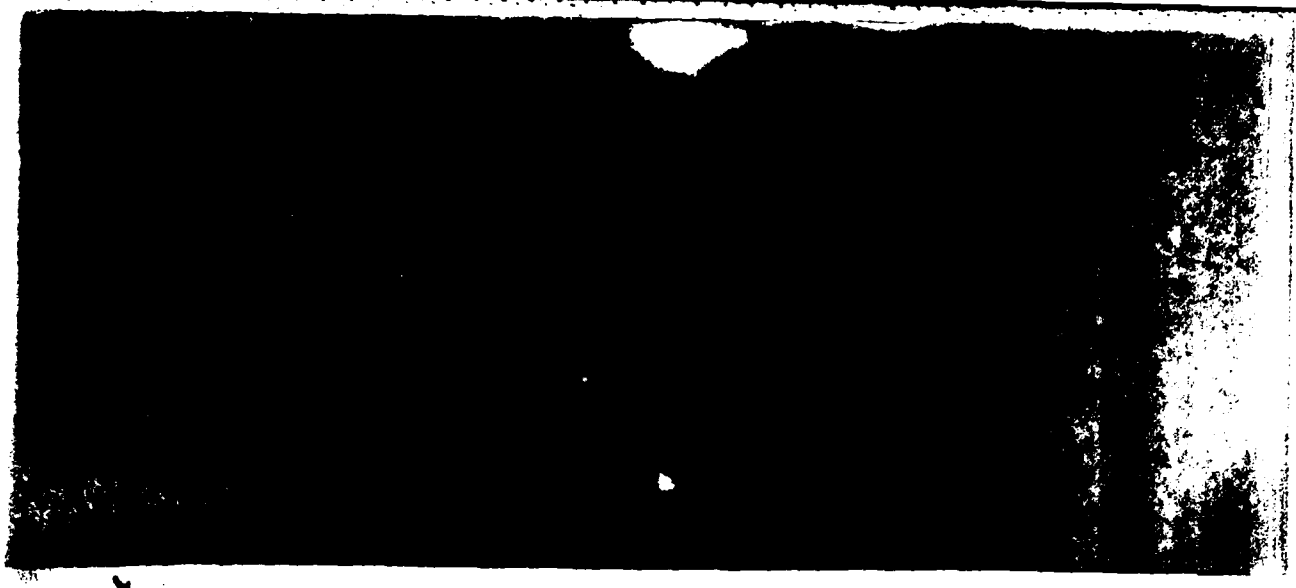
Leaks____

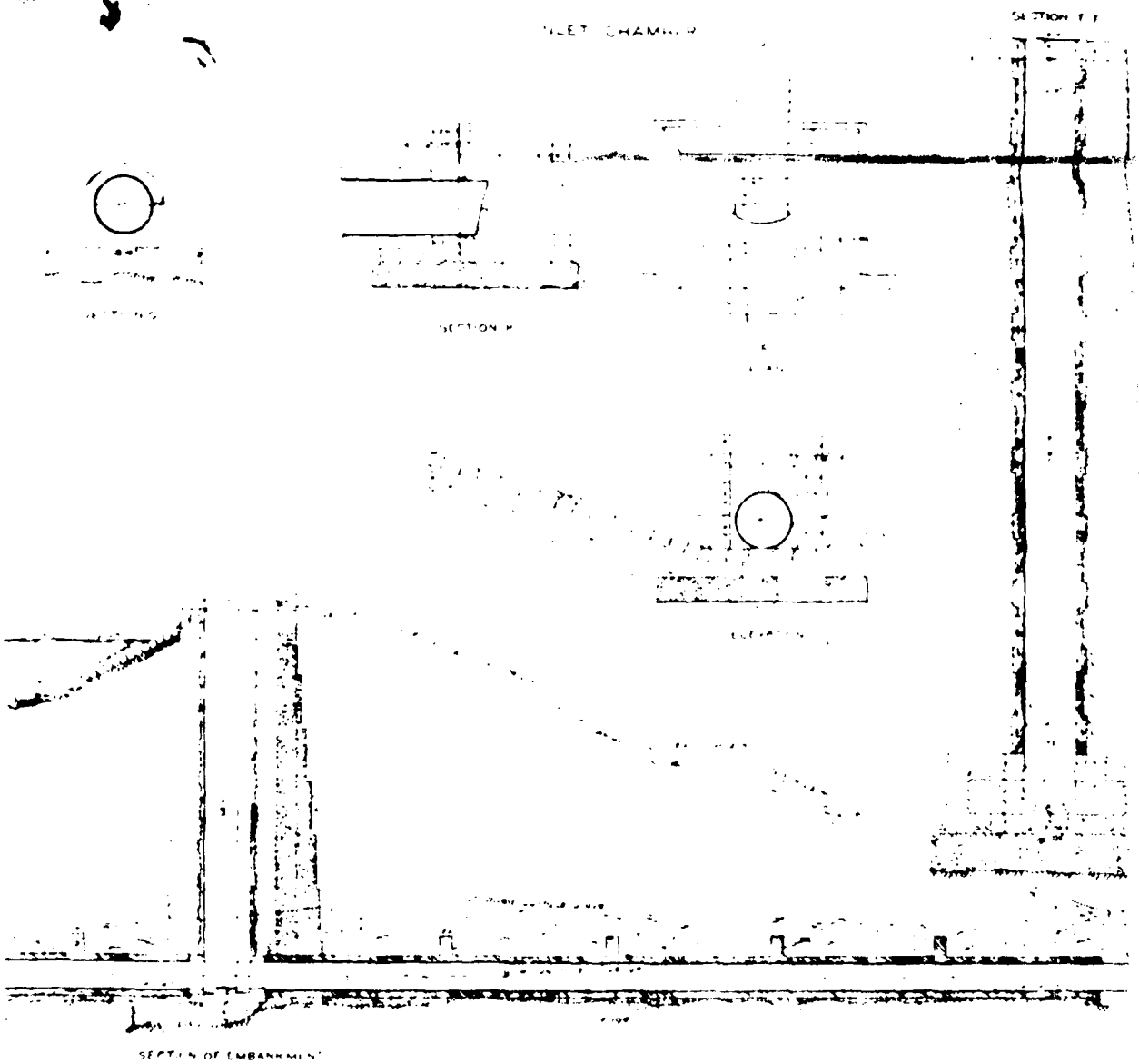
Trash and/or debris impeding flow____

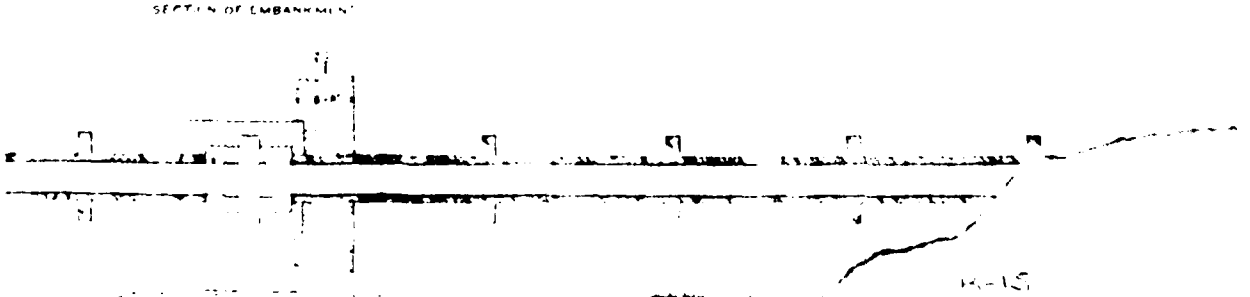
Clogged or blocked spillway____

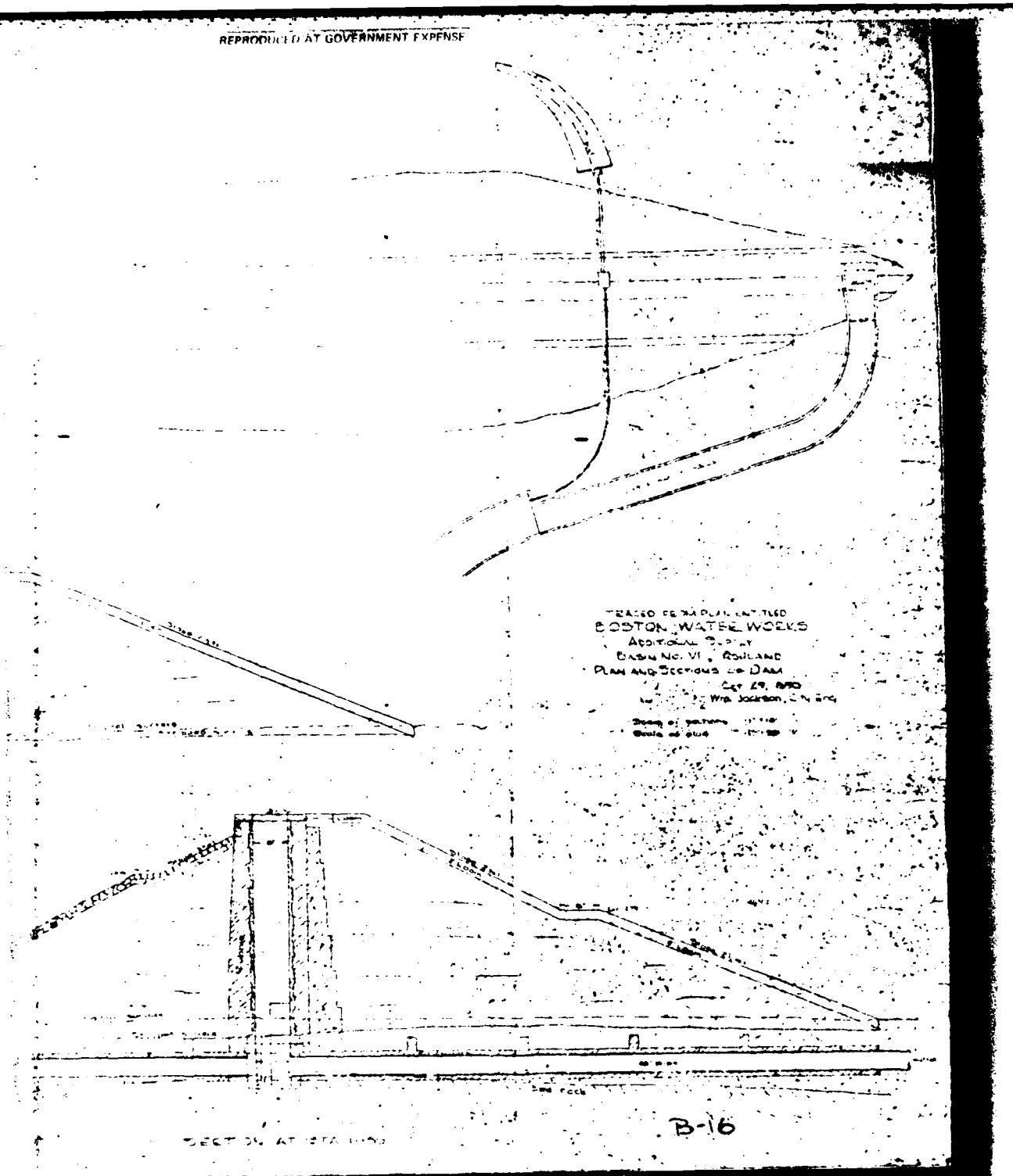
Other NO DEFICIENCIES NOTED


SECTION C-D
BASIN No. VI, ASHLAND.

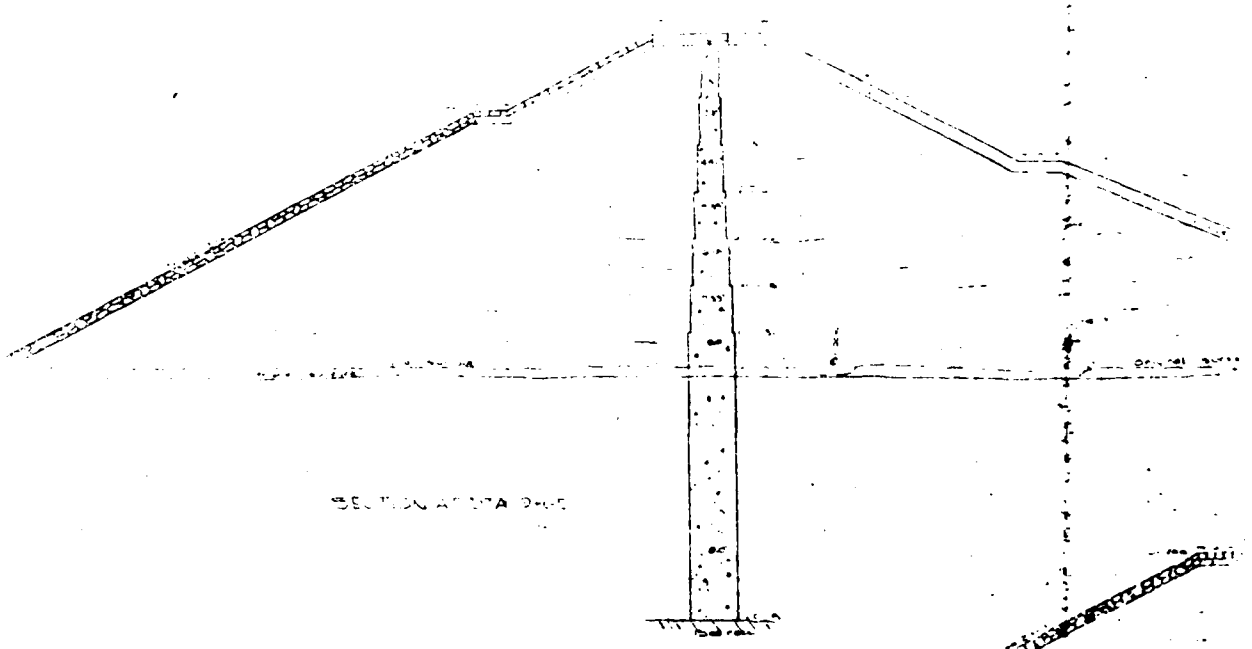


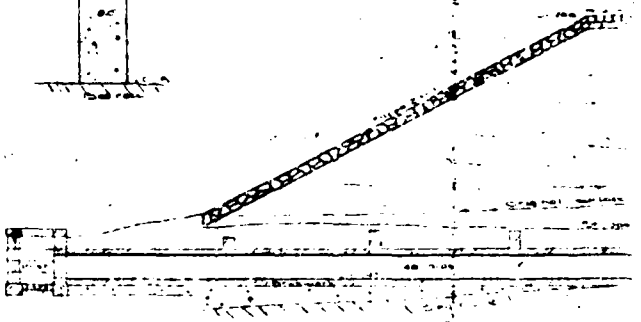

SECTION F-F
SECTION E

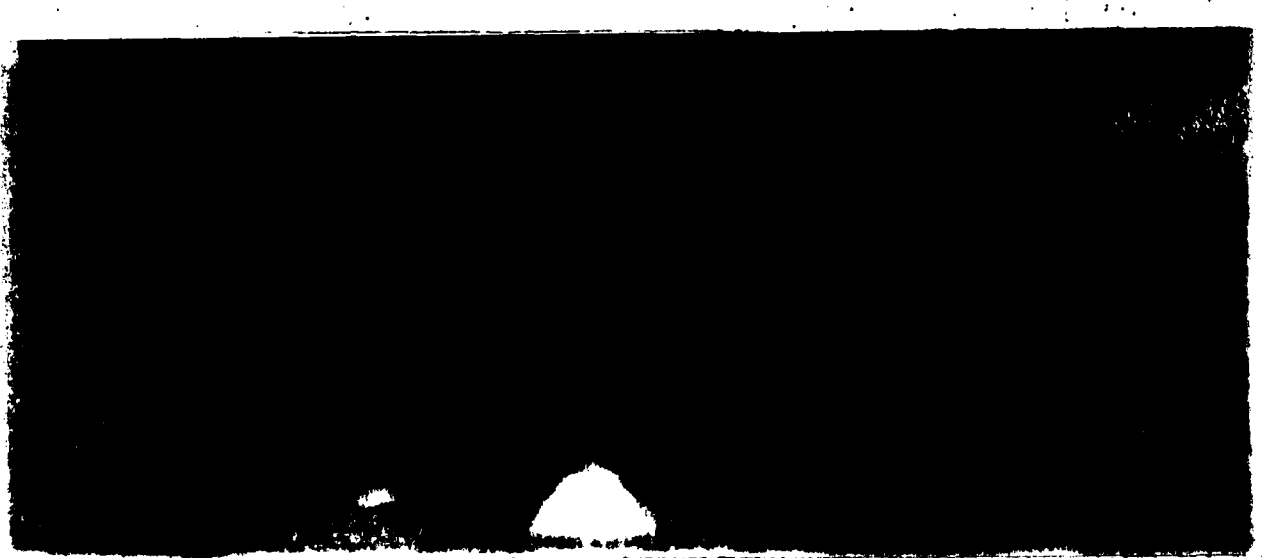

SECTION OF EMBANKMENT

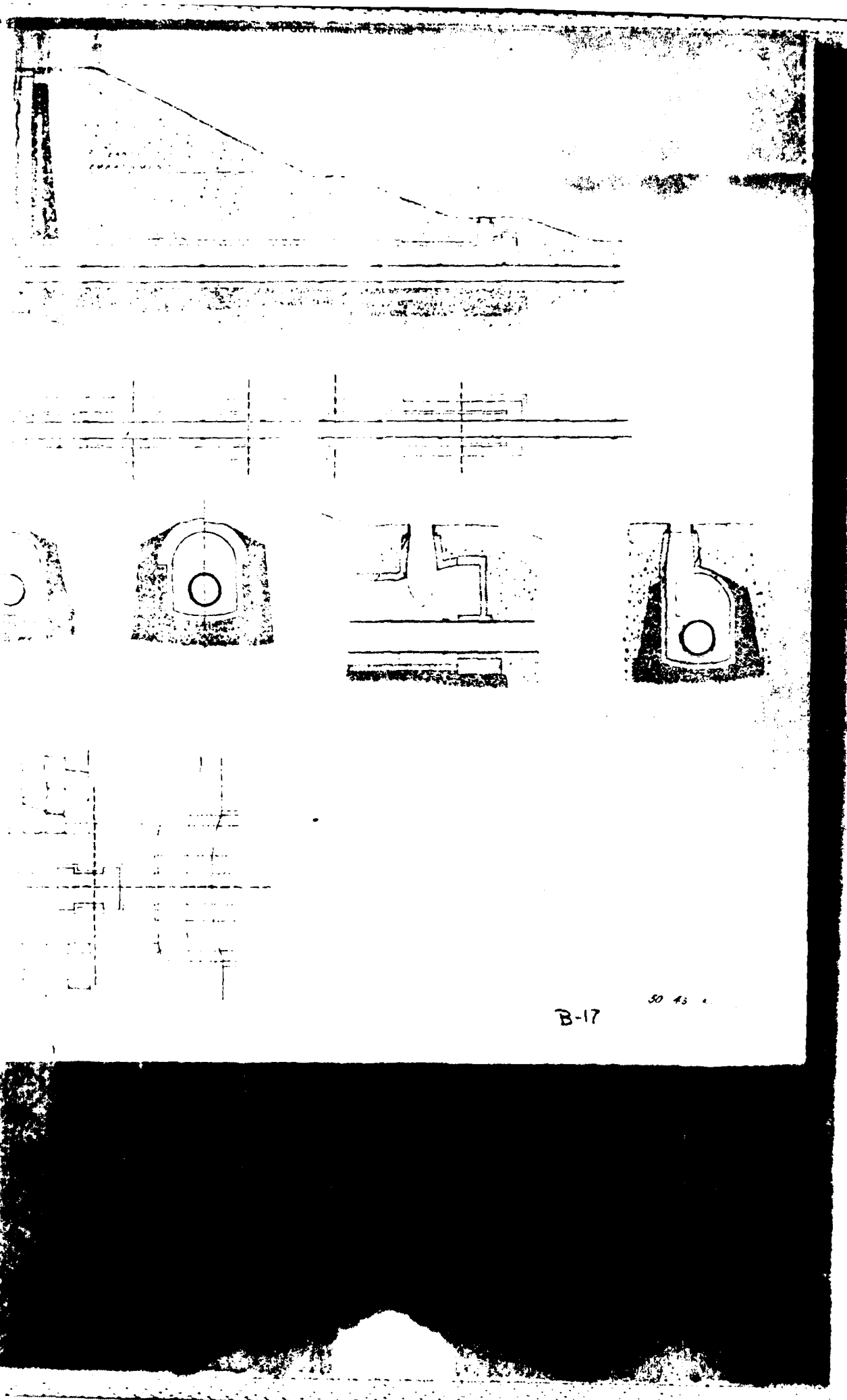


B-16

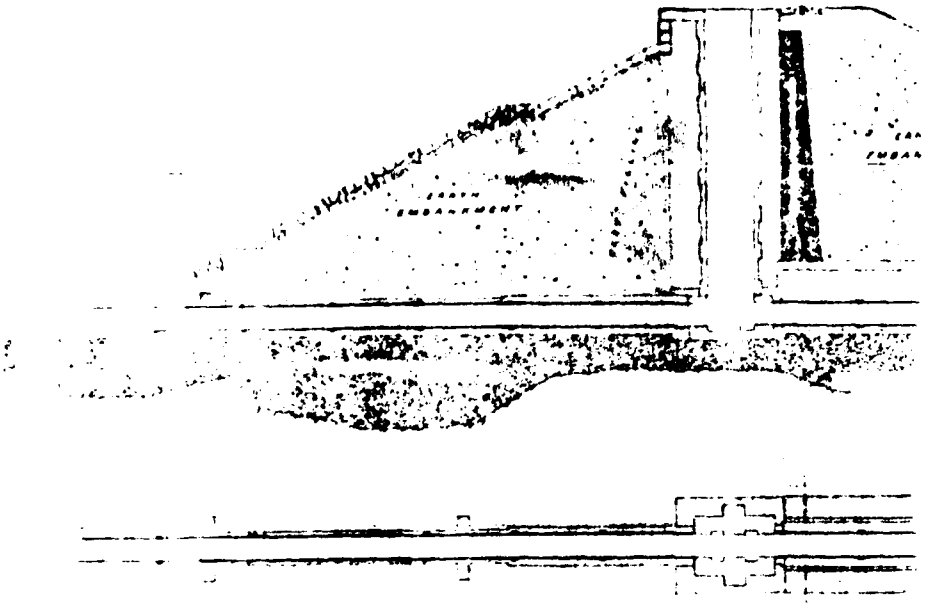


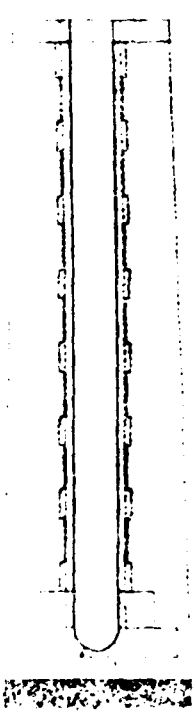


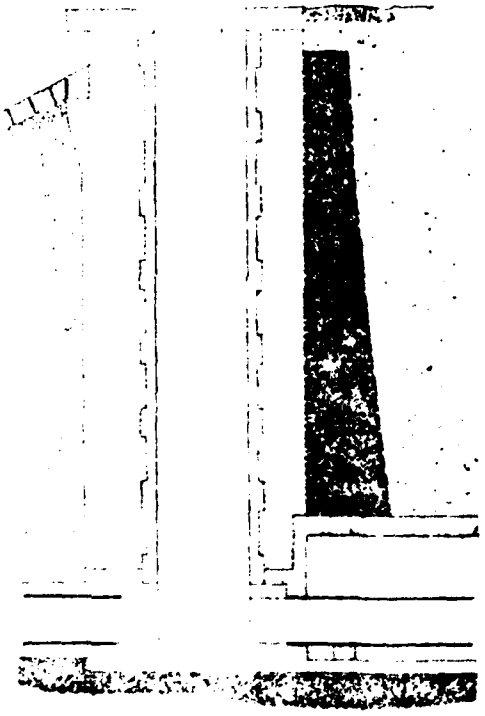


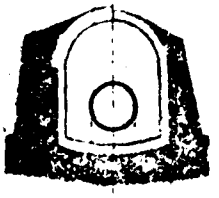


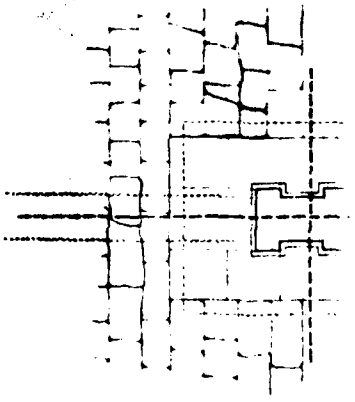
B-17





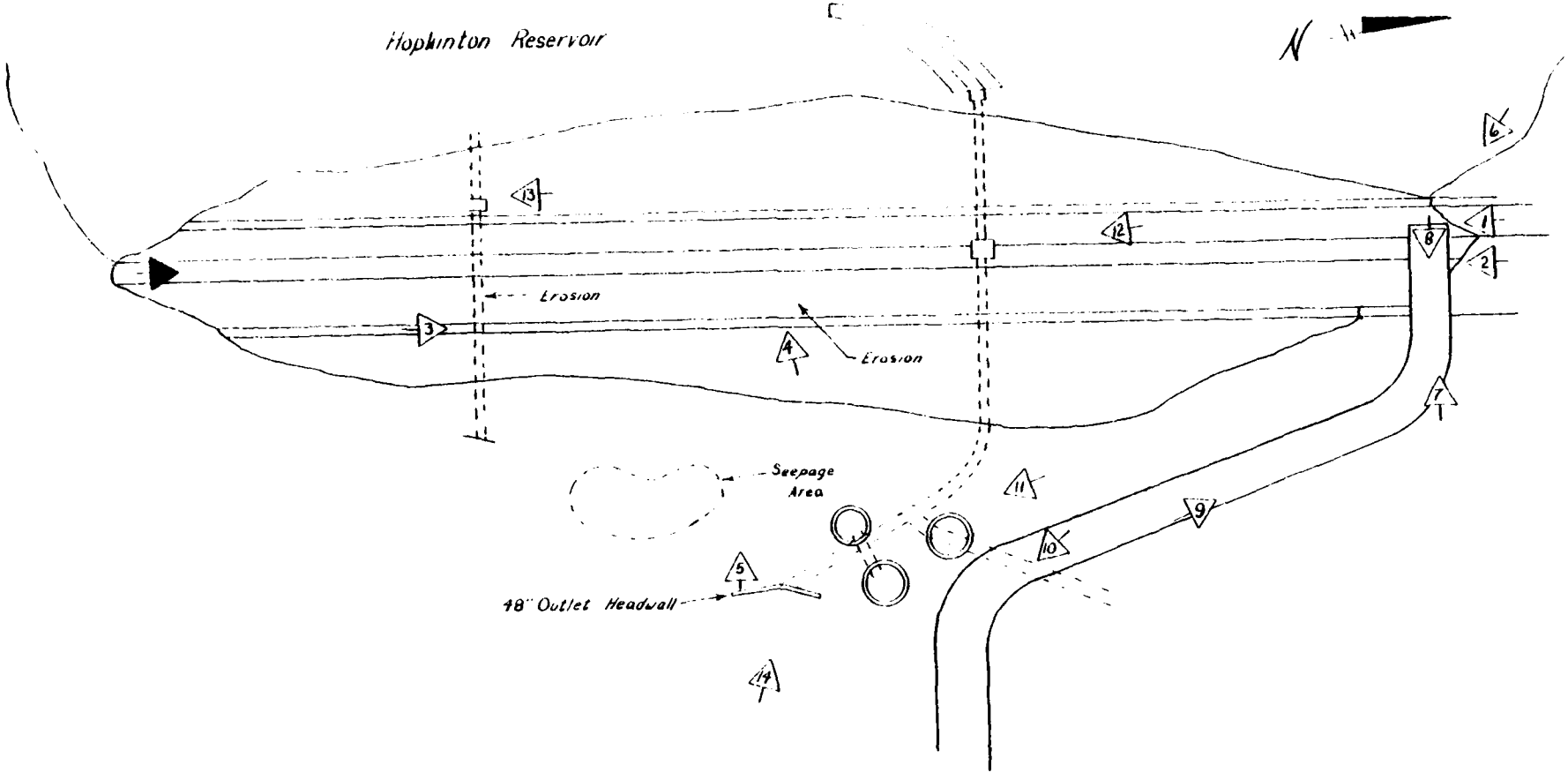






Appendix C

Photos



Overview Photo

Appendix "C" Photos

LOUIS BERGER & ASSOC., INC. WELLESLEY, MASS. ARCHITECT ENGINEER	US ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

HOPKINTON RESERVOIR DAM

SKETCH PLAN SHOWING LOCATION & ORIENTATION OF PHOTOS

STATE - MA.

SCALE NOT TO SCALE

DATE

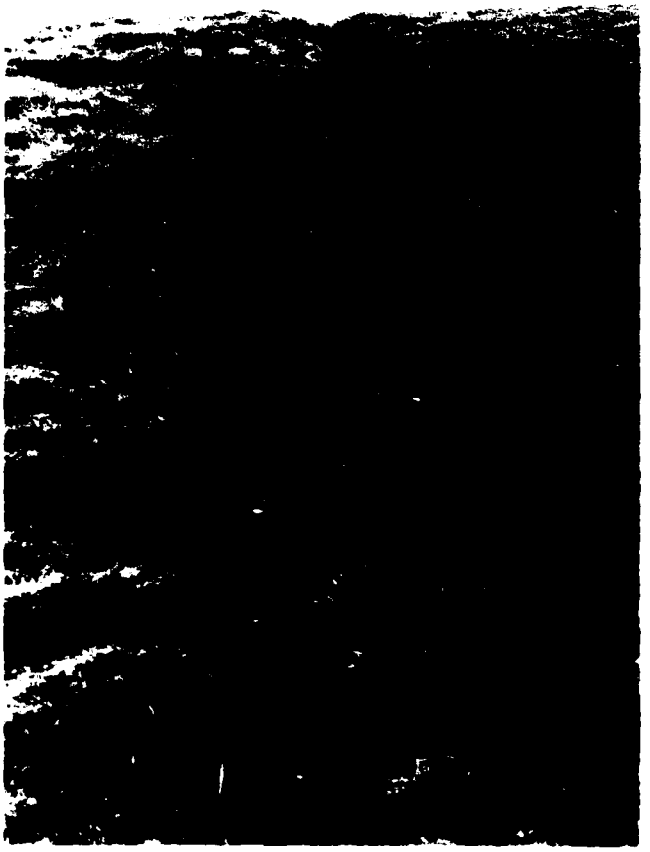
C1

HOPKINTON RESERVOIR DAM

1. Upstream slope of dam covered with hand placed granite block.

2. Downstream slope of dam

3. Berm at mid-height of downstream slope.



4. Minor erosion on downstream slope.

5. Seepage area at downstream toe of dam near 48 in. dia. pipe headwall.

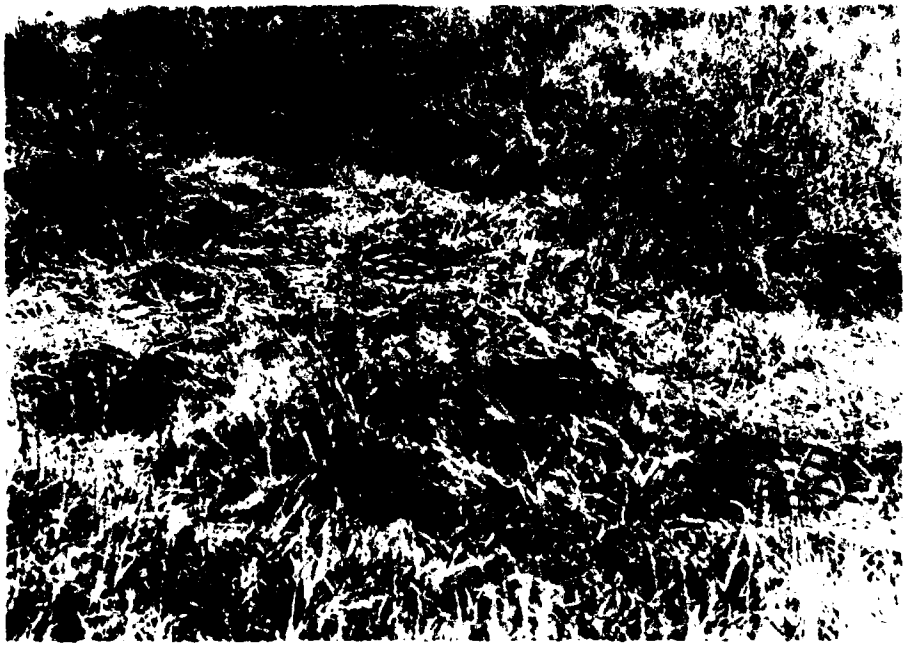
6. Spillway approach channel.

7. View of spillway from downstream channel.

8. Stepped granite block downstream spillway channel.

. View of spillway channel from downstream toe.

.0. Granite block and concrete channel and earth embankment channel beyond downstream toe of spillway channel.



1. Downstream controls for 48 in. dia. outlet structure.

2. Left outlet gate chamber.

TRY 1/2 PMF = $\frac{9,600}{2}$ = 4,800 CFS

STEP 1: Q_{P1} = 4,800 CFS

STEP 2a: ELEV. = 306.75

STEP 2b: SURCHARGE VOLUME = 2,750 A.F.

INCHS RUNOFF = $\frac{2750 \times 12}{4019}$ = 8.21 INCHS

STEP 2c: $Q_{P2} = 4,800\left(1 - \frac{8.21}{9.5}\right)$

Q_{P2} = 652 CFS

STEP 3a FOR Q = 652 CFS

SURCHARGE HEIGHT = 302.60

" VOLUME = 910 A.F.

INCHS RUNOFF = $\frac{910 \times 12}{4019}$ = 2.72 INCHS

STEP 3b AVE. STORAGE = $\frac{2.72 + 8.21}{2}$ = 5.46

2ND ITERATION

STEP 2c $Q_{P2} = 4,800\left(1 - \frac{5.46}{9.5}\right)$

Q_{P2} = 2041

STEP 3a FOR Q = 2041

SURCHARGE HEIGHT = 306.10

$$\frac{\text{Stor 1} + \text{Stor 2}}{2} = \frac{8.58 + 8.36}{2} = 8.47$$

4TH ITERATION

STEP 2c $Q_{P2} = 9{,}600 \left(1 - \frac{8.47}{19}\right)$

$Q_{P2} = 5{,}320$ CFS

SURCHARGE HEIGHT = 306.85

SURCHARGE VOLUME = 2,810

INCHES RUNOFF = $\frac{2810 \times 12}{4019} = 8.34$

STEP 3b $\overline{\text{Stor}} = \frac{8.47 + 8.39}{2} = 8.43$ IN

AVE SURCHARGE VOL = $\frac{8.43 \times 4019}{12} = 2823$

" " HEIGHT = 306.86

$Q_{P3} = 5{,}400$ CFS

PMF OVERTOPS EMBANKMENT BY 306.86
− 306.00
0.86 FT

SAY H = 0.85 FT
Q = 5,400 CFS

STEP 3b

$$\text{AVE. STORAGE} = \frac{9.44 + 8.21}{2} = 8.82 \text{ INCHES}$$

2ND ITERATION

STEP 2c $Q_{P2} = 9,600\left(1 - \frac{8.82}{19}\right)$

$Q_{P2} = 5144$ CFS

STEP 3e FOR Q = 5144 CFS

SURCHARGE HEIGHT = 306.81

SURCHARGE VOLUME = 2,790 A.F.

INCHES RUNOFF = $\frac{2790}{4019} \times 12 = 8.33$ IN.

$$\frac{\text{STOR}_1 + \text{STOR}_2}{2} = \frac{8.82 + 8.33}{2} = 8.58 \text{ IN}$$

3RD ITERATION

STEP 2c $Q_{P2} = 9,600\left(1 - \frac{8.58}{19}\right)$

$Q_{P2} = 5265$

STEP 3e FOR Q = 5265

SURCHARGE HEIGHT = 306.84

SURCHARGE VOLUME = 2,800 A.F.

INCHES RUNOFF = $\frac{2800 \times 12}{4019} = 8.36$ IN.

BY RFB DATE 1-12-81 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 1 OF 7

CHKD. BY DATE PROJECT W-198

SUBJECT HOPKINTON RESERVOIR DAM, RESERVOIR ROUTING

DRAINAGE AREA = 6.28 SQ.MI = 4,019 ACRES

SIZE CLASSIFICATION - INTERMEDIATE

MAXIMUM STORAGE = 6848

HEIGHT = 58 FT

HAZARD CLASSIFICATION - HIGH

OCE GUIDELINES, USE FULL PMF

FROM INFLOW HYDROGRAPH, PMF = 9,600 CFS

STEP 1: $Q_{P1} = 9{,}600$ CFS

STEP 2a: ELEV = 307.48 FT

STEP 2b: SURCHARGE VOLUME = 3,160 A.F.

$$\text{INCHES OF RUNOFF} = \frac{3{,}160 \text{ AF}}{4019 \text{ A.}} \times 12 \text{ IN/FT} = 9.44 \text{ IN.}$$

STEP 2c: $Q_{P2} = 9{,}600 \left(1 - \frac{9.44}{19}\right)$

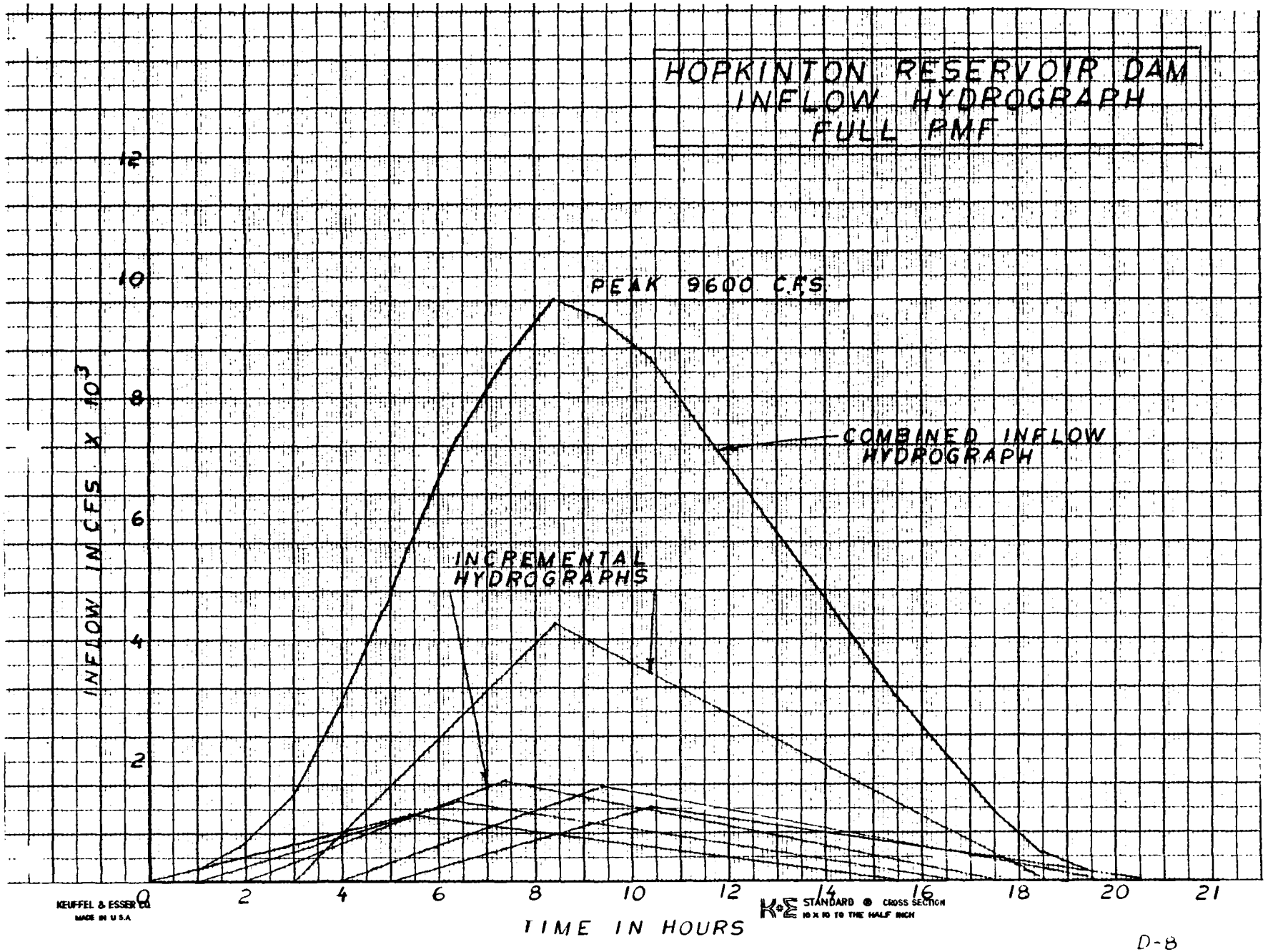
$$Q_{P2} = 4830 \text{ CFS}$$

STEP 3a: FOR Q = 4,830

SURCHARGE HEIGHT = 306.75 FT

SURCHARGE VOLUME = 2,750 A.F.

$$\text{INCHES RUNOFF} = \frac{2750}{4019} \times 12 = 8.21 \text{ INCHES}$$


HOPKINTON RESERVOIR DAM
INFLOW HYDROGRAPH
FULL PMF
PEAK 9600 C.F.S.
COMBINED INFLOW HYDROGRAPH
INCREMENTAL HYDROGRAPHS
INFLOW IN CFS X 10³
0
2
4
6
8
10
12
14
16
18
20
21
TIME IN HOURS
KEUFFEL & ESSER CO.
MADE IN U.S.A.
K+E STANDARD ® CROSS SECTION
10 X 10 TO THE HALF INCH

$T_R = 1.67\,T_p = 1.67(6.05) = 10.10$ HRS

$T_B = T_p + T_R = 5.37 + 10.10 = 15.47$ HRS

$$q_p = \frac{484\,A\,Q}{T_p}$$, A = DRAINAGE AREA, Q = RUNOFF IN INCHS

$$q_p = \frac{484\,(6.28)(1)}{5.37} = 566 \text{ CFS}$$

PMP = 25.2 (0.8) = 20.2" FOR HOPKINTON, MASS

= 19.8" CONSIDERING INFILTRATION FOR OVERLAND FLOW.

FLOOD HYDROGRAPH FOR PMF $q_p = 566$

TIME HOURS	RAINFALL * %	RAINFALL INCHS	Qp CFS	TIME BEGIN	TIME PEAK	TIME END
0.0						
1	10	1.98	1121	0	5.4	15.5
2	12	2.38	1347	1.0	6.4	16.5
3	15	2.97	1681	2.0	7.4	17.5
4	38	7.52	4256	3.0	8.4	18.5
5	14	2.77	1568	4.0	9.4	19.5
6	11	2.18	1234	5.0	10.4	20.5

* DISTRIBUTION OF MAXIMUM 6 HOUR PMP IN PERCENT OF 6 HOUR AMOUNT PER EM 110-2-1411

BY RFB DATE 1-8-61 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 1 OF 2

CHKD. BY DATE PROJECT W-198

SUBJECT HOPKINTON DAM, INFLOW HYDROGRAPH

DRAINAGE AREA (TOTAL) = 6.28 SQ. MI
BY INSPECTION AREA < 25% D.A.

LONGEST WATER COURSE, $L = 25{,}000$ FT $= 4.73$ MI

ELEV. DIFFERENCE = $490 - 299 = 191$ FT

$\therefore$ SLOPE $= \frac{191}{4.73} = 40.38$ FT/MI & $\sqrt{S} = 6.35$

$$\text{Now} \left(\frac{L L_c}{\sqrt{S}}\right)^{.33} = \left[\frac{4.73 \times 4.73}{6.35\,(2)}\right]^{.33} = 1.21$$

$$\text{LAG} = K \left(\frac{L L_c}{\sqrt{S}}\right)^{.33} = 1.21\,K$$

ASSUME $K = 5.0$ HRS — REFER TO "CURVE B" MOUNTAINOUS REGION, MIXED TERRAIN, BOR REC

$\text{LAG} = 1.21\,(5) = 6.05$ HRS

$T_p = 0.41D + 0.82\,\text{LAG}$, WHERE $D = 1.0$ HRS

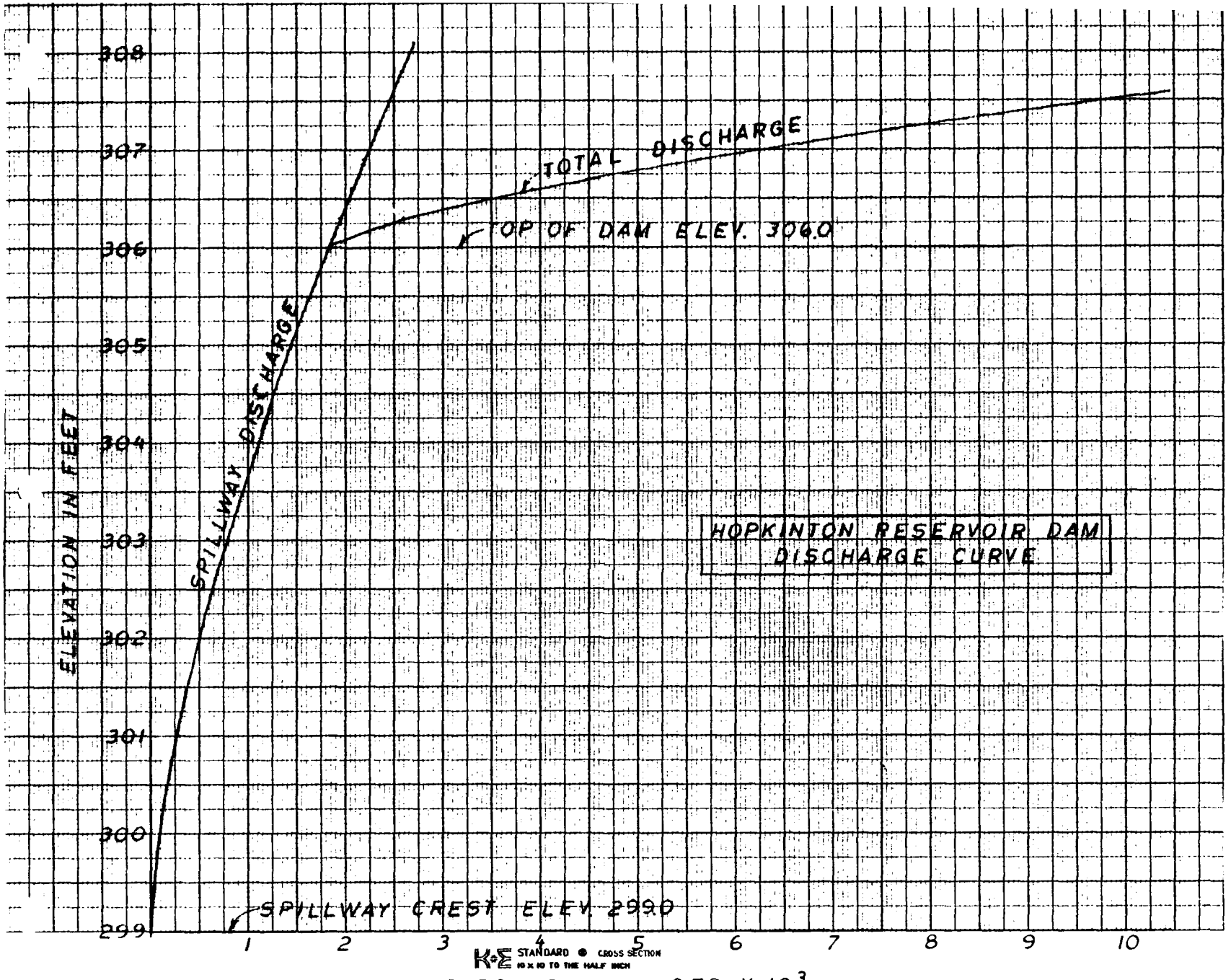
$T_p = 0.41\,(1) + 0.82\,(6.05)$

$T_p = 0.41 + 4.96 = 5.37$ HRS

CHECK VELOCITY $\quad T_c = \frac{T_p - 0.5D}{0.6}$

$$T_c = \frac{5.37 - 0.5}{0.6} = 8.12$$

$$V = \frac{25{,}000}{(8.12)(3600)} = 0.86 \text{ FT/SEC.} \quad \text{O.K.}$$



HOPKINTON RESERVOIR DAM
DISCHARGE CURVE

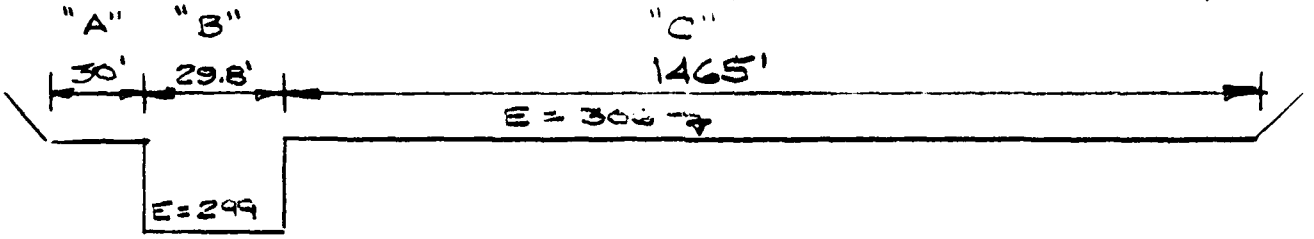
K+E STANDARD ● CROSS SECTION
10 x 10 TO THE HALF INCH

D-5

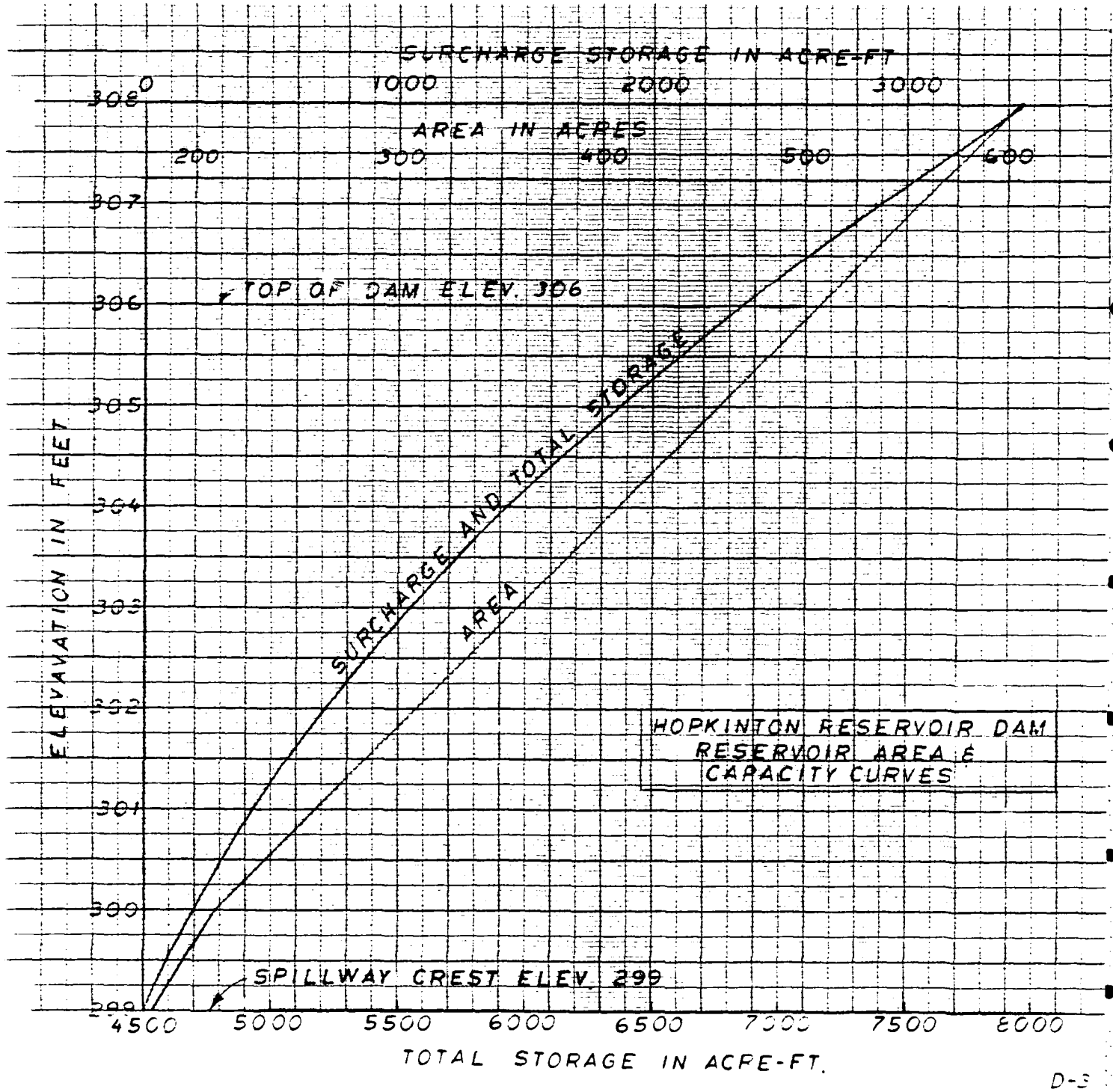
BY RFB DATE 1-12-81 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 1 OF 1

CHKD. BY _____ DATE _____ PROJECT W-198

SUBJECT HOPKINTON RESERVOIR DAM, DISCHARGE CAPACITY



ELEV.	"B", C=3.3			"A"+"C", C=2.7			Σ
299	H	L	Q	H	L	Q	Q
300	1	29.8	98	0	1495	0	100
301	2		278	0		0	280
302	3		501	0		0	500
303	4		787	0		0	785
304	5		1099	0		0	1100
305	6		1445	0		0	1445
306	7		1821	0		0	1820
306.3	7.3		1940	0.3		663	2600
306.6	7.6		2060	0.6		1875	3935
306.9	7.9		2183	0.9		3447	5630
307.2	8.2		2309	1.2		5306	7615
307.5	8.5		2437	1.5		7422	9860
307.8	8.8		2567	1.8		9748	12315
308.1	9.1		2700	2.1		12285	14985



HOPKINTON RESERVOIR DAM
RESERVOIR AREA & CAPACITY CURVES

D-3

BY [illegible] DATE [illegible]

LOUIS BERGER & ASSOCIATES INC.

SHEET NO 1 OF 1

CHKD. BY _____ DATE _____

PROJECT W-1[illegible]

SUBJECT [illegible] RESERVOIR - DAM & STORAGE CAPACITY

NORMAL [illegible] EL. 300 ; EL. H = 300 - 249 = 51

SURFACE AREA = 180 ACRES

VOLUME = 1/2 HA = 1/2 (51)(180) = 4590 ACRE-FT

FROM THE USE INVENTORY SURVEY VOLUME CHART AT

SAY NORMAL STORAGE = 4,500 ACRE-FT

ELEV. FT	AREA ACRES	AVE. AREA	H FT.	Δ VOLUME	TOTAL VOLUME	SURFACE VOLUME
299	180				4590	
300	211	196	1	196	4696	196
301	260	236		236	4932	432
302	309	284		284	5216	716
303	359	334		334	5550	1050
304	408	384		384	5934	1434
305	457	432		432	6366	1866
306	506	482		482	6848	2348
307	555	530		530	7378	2878
308	605	580		580	7958	3458
309	654	630		630	8588	4088
310	703	678		678	9266	4766

BY [illegible] DATE 10-8-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 1 OF 1

CHKD. BY _____ DATE _____ PROJECT [illegible]

SUBJECT [illegible]

FIND [illegible] AREAS [illegible]

READ #2 29.65 READ #3 143.34
#1 55.43 #2 99.65
43.72 43.74 AVE 43.73

AREA = 43.73 X 0.1435 = 6.28 SQ MI

FIND RESERVOIR AREA, ELEV 294

READ #2 45.80 READ #3 47.75
#1 43.82 #2 45.80
1.98 1.95 AVE 1.96

AREA = 1.96 X 2.82 = 5.53 AC

AREA ELEV 300

READ #2 44.70 READ #3 46.73
#1 42.39 #2 44.70
2.31 2.03 AVE 2.17

AREA = 2.17 X 1.82 = 3.95 AC

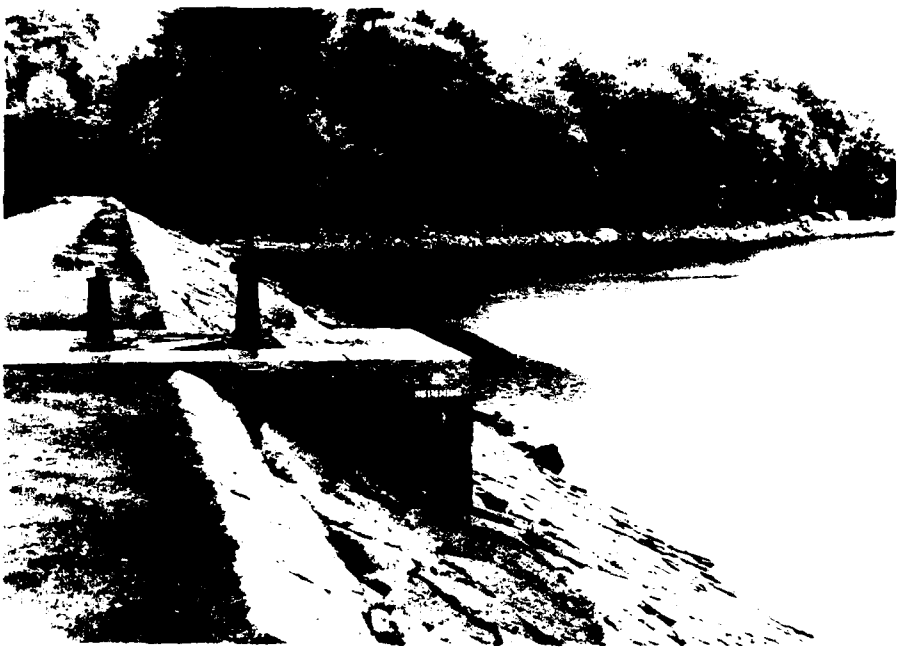
AREA ELEV 310

READ #2 50.48 READ #3 52.41
#1 42.82 #2 50.41
7.66 7.00 AVE 7.33

AREA = 7.33 X 1.82 = 13.34 AC

Appendix D

Hydrologic and Hydraulic Computations



13. Right outlet gate chamber.

14. Granite block headwall for 48 in. dia. outlet pipe.

SURCHARGE VOL = 2,400 A.F.

$$\text{INCHS RUNOFF} = \frac{2,400 \times 12}{4019} = 7.17 \text{ INCHS}$$

$$\frac{\text{STOR 1} + \text{STOR 2}}{2} = \frac{5.46 + 7.17}{2} = 6.32 \text{ INCHS}$$

3RD ITERATION

STEP 2c $Q_{P2} = 4,800\left(1 - \frac{6.32}{9.5}\right)$

$Q_{P2} = 1,607$ CFS

STEP 3a FOR Q = 1,607 CFS

SURCHARGE HEIGHT = 305.45

" VOLUME = 2,080 A.F.

$$\text{INCHS RUNOFF} = \frac{2080 \times 12}{4019} = 6.21 \text{ INCHS}$$

$$\frac{\text{STOR 1} + \text{STOR 2}}{2} = \frac{6.32 + 6.21}{2} = 6.265$$

4TH ITERATION

STEP 2c $Q_{P2} = 4,800\left(1 - \frac{6.265}{9.5}\right)$

$Q_{P2} = 1635$ CFS

SURCHARGE HEIGHT = 305.50

" VOLUME = 2130 A.F.

$$\text{INCHS RUNOFF} = \frac{2130 \times 12}{4019} = 6.36 \text{ INCHS}$$

STEP 3b $\overline{SUR} = \frac{6.265 + 6.36}{2} = 6.31$ INS

AVE SURCHARGE $Vol = \frac{6.31 \times 4019}{12} = 2113$ A.F.

" " HEIGHT = 305.5

$Q_{P3} \cong 1630$ CFS

½ PMF DOES NOT OVERTOP EMBANKMENT

HEIGHT OF WATER BELOW TOP OF DAM: 306.0 − 305.5 = 0.5 FT

SAY Q = 1,630

STEP 1: RESERVOIR ELEVATION @ FAILURE = 306 FT
WATER @ CREST OF EMBANKMENT
STORAGE = 6,850 A.F.

HEIGHT = 58 FT = Y_o
LENGTH @ MIDHEIGHT = 1190 FT = L

$W = 20\% L = 0.20(1190) = 238$

STEP 2: PEAK FAILURE OUTFLOW

$$Q_{P_1} = 8/27 (W) \sqrt{g}\, Y_o^{3/2}$$

$$Q_{P_1} = 1.68 (238)(58)^{3/2}$$

$$Q_{P_1} = 176{,}600 \text{ CFS}$$

ADD SPILLWAY FLOW: $Q_{SPILLWAY} = 1820$

$$Q_{P_1 (TOTAL)} = 176{,}600 + 1{,}820$$

SAY $Q_{P_1} = 178{,}400$ CFS

STA 0+00 TO 20+00

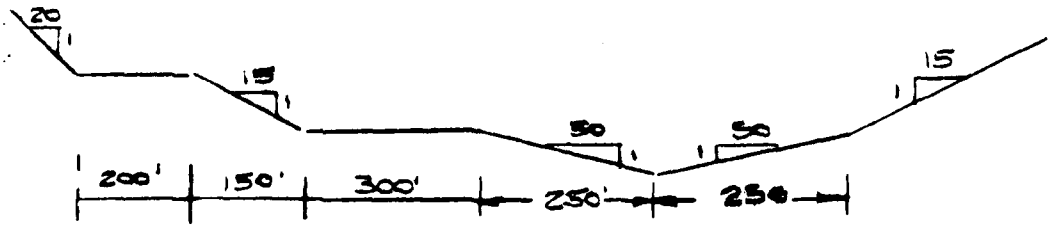
$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$Q = 3.53 A R^{2/3}$$

$$S = \frac{23}{2{,}000}$$

$$S = .0115$$

$$S^{1/2} = 0.107$$



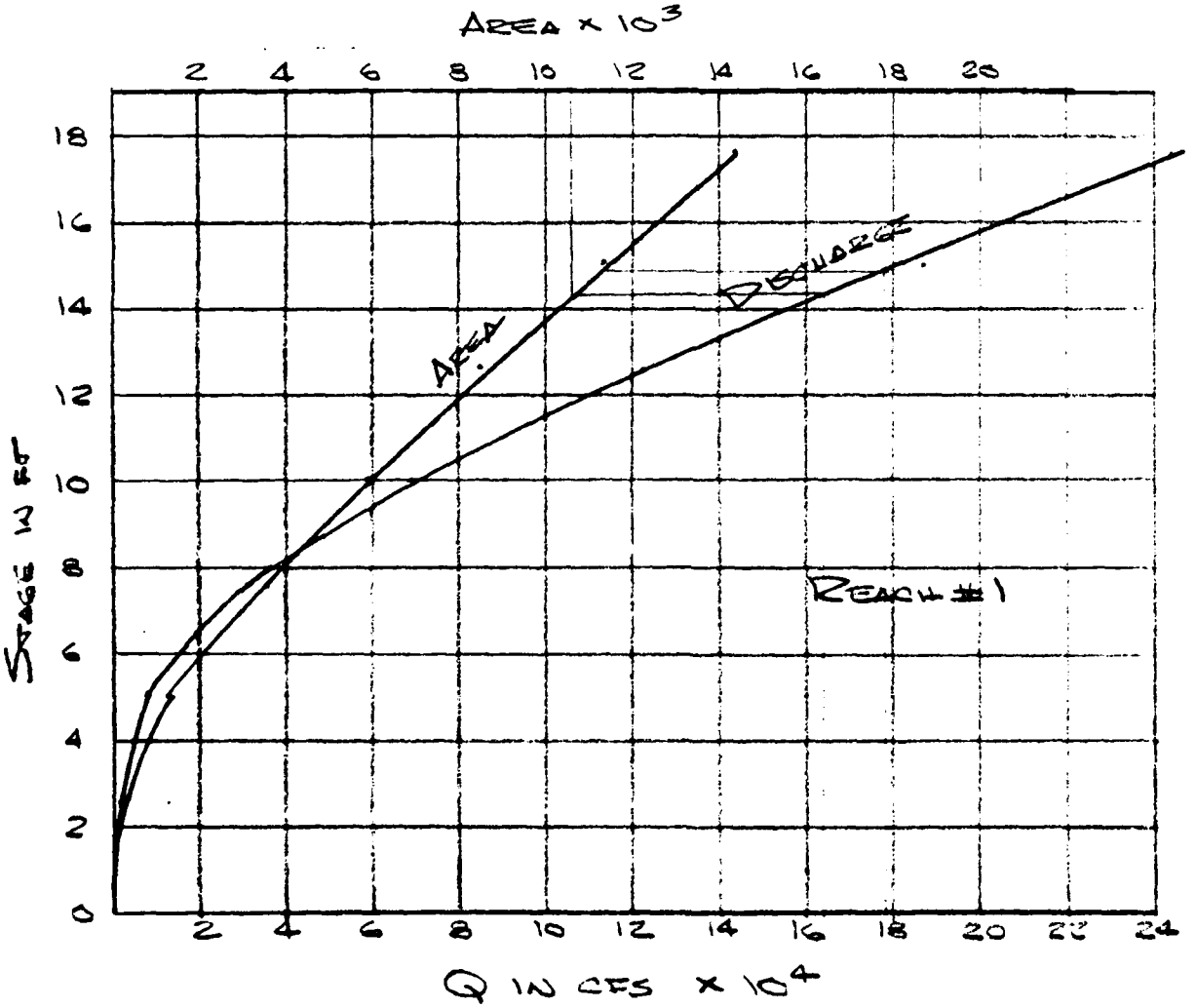
$n = 0.045$

BY RFB DATE 1-13-81 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 2 OF 10

CHKD. BY _____ DATE _____ PROJECT W-198

SUBJECT HOPKINTON RESERVOIR - DOWNSTREAM ANALYSIS

STAGE	AREA	P	$R^{2/3}$	Q
2.5	312	250	1.16	1277
5	1250	500.1	1.84	8120
7.5	3468	875.3	2.51	30730
10	5875	930.5	3.37	69890
12.5	8469	1025.6	4.09	122270
15	11250	1100.8	4.71	187,050
17.5	14360	1358.5	4.82	244,300
20	17337	1416.3	5.31	



FOR Q = 178,000, STAGE = 14.9, AREA = 11,300 FT²

$$V_1 = \frac{11,300 \times 2000}{43,560} = 519 \text{ A.F.}$$

$$Q_{P2(TRIAL)} = 178,000\left(1 - \frac{519}{6850}\right)$$

$$= 164,500 \text{ CFS}$$

FOR Q = 164,000, STAGE = 14.3, AREA = 10,700 FT²

$$V_2 = \frac{10,700 \times 2000}{43,560} = 492 \text{ A.F.}$$

$$V_{AVE} = \frac{519 + 492}{2} = 506 \text{ A.F.}$$

$$Q_{P2} = 178,000\left(1 - \frac{506}{6850}\right) = 164,850 \quad H = 14.3$$

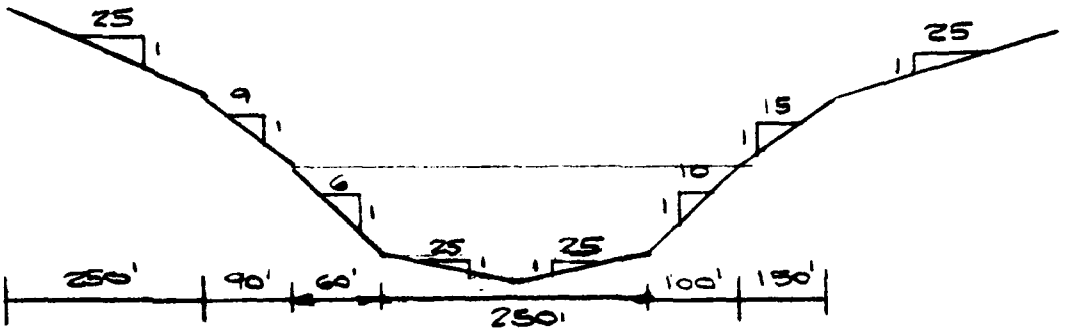
STA 20+00 TO STA 68+00

$$S = \frac{245 - 200}{4800} = .009$$

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2} \qquad S^{1/2} = .095$$

$$n = 0.40$$

$$Q = 3.53 A R^{2/3}$$

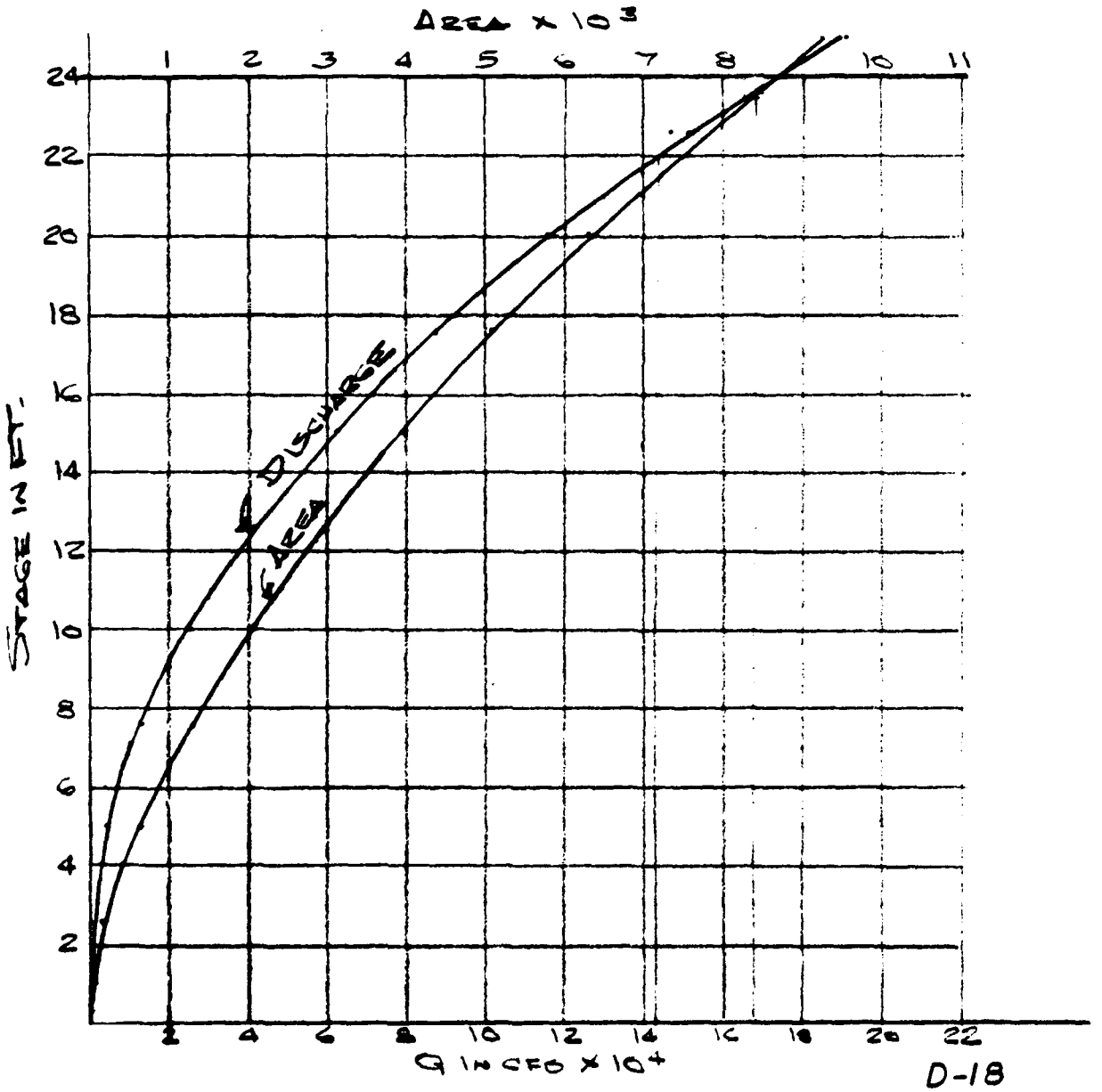


BY RFB DATE 1-13-81 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 4 OF 10

CHKD. BY ____ DATE ____ PROJECT W-198

SUBJECT HOPKINTON RESERVOIR + FAILURE ANALYSIS

STAGE	AREA	P	$R^{2/3}$	Q
2.5	156	125.1	1.16	626
5	625	250.2	1.84	4060
7.5	1300	290.5	2.72	12482
10	2075	330.9	3.40	24904
12.5	2950	371.2	3.98	41445
15	3925	411.5	4.50	62349
17.5	5072	471.7	4.88	87,372
20	6275	531.9	5.19	114,962
22.5	7590	592.2	5.48	146,824
25	9225	652.4	5.85	190,500



FOR Q = 164,800, STAGE = 23.4 AREA = 8,500 FT²

$$V_1 = \frac{8,500 \times 4800}{43,560} = 937 \text{ AF}$$

$$Q_{P_2(TRIAL)} = 164,800\left(1 - \frac{937}{6850}\right)$$

$$= 142,250 \text{ CFS}$$

FOR Q = 142,300, STAGE = 22 FT, AREA = 7500

$$V_2 = \frac{7500 \times 4800}{43,560} = 826 \text{ AF}$$

$$V_{AVE} = \frac{937 + 826}{2} = 882 \text{ AF}$$

$$Q_{P_2} = 164,800\left(1 - \frac{882}{6850}\right)$$

$$= 143,600 \text{ CFS}, \text{ STAGE } 22.1 \text{ FT.}$$

REACH #3, STA 48+00 TO 96+00

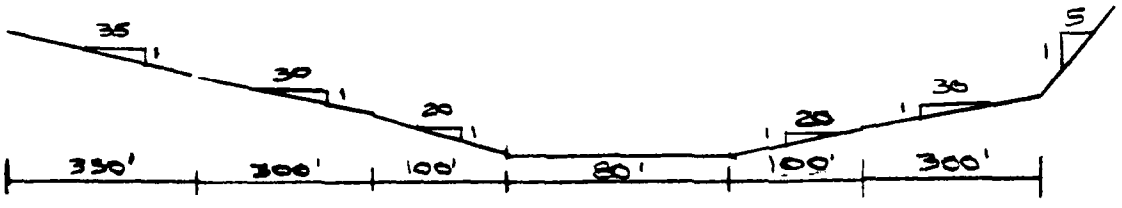
$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$Q = 1.71 A R^{2/3}$$

$$S = \frac{10}{4800} = .0021$$

$$S^{1/2} = 0.046$$

$$n = 0.040$$

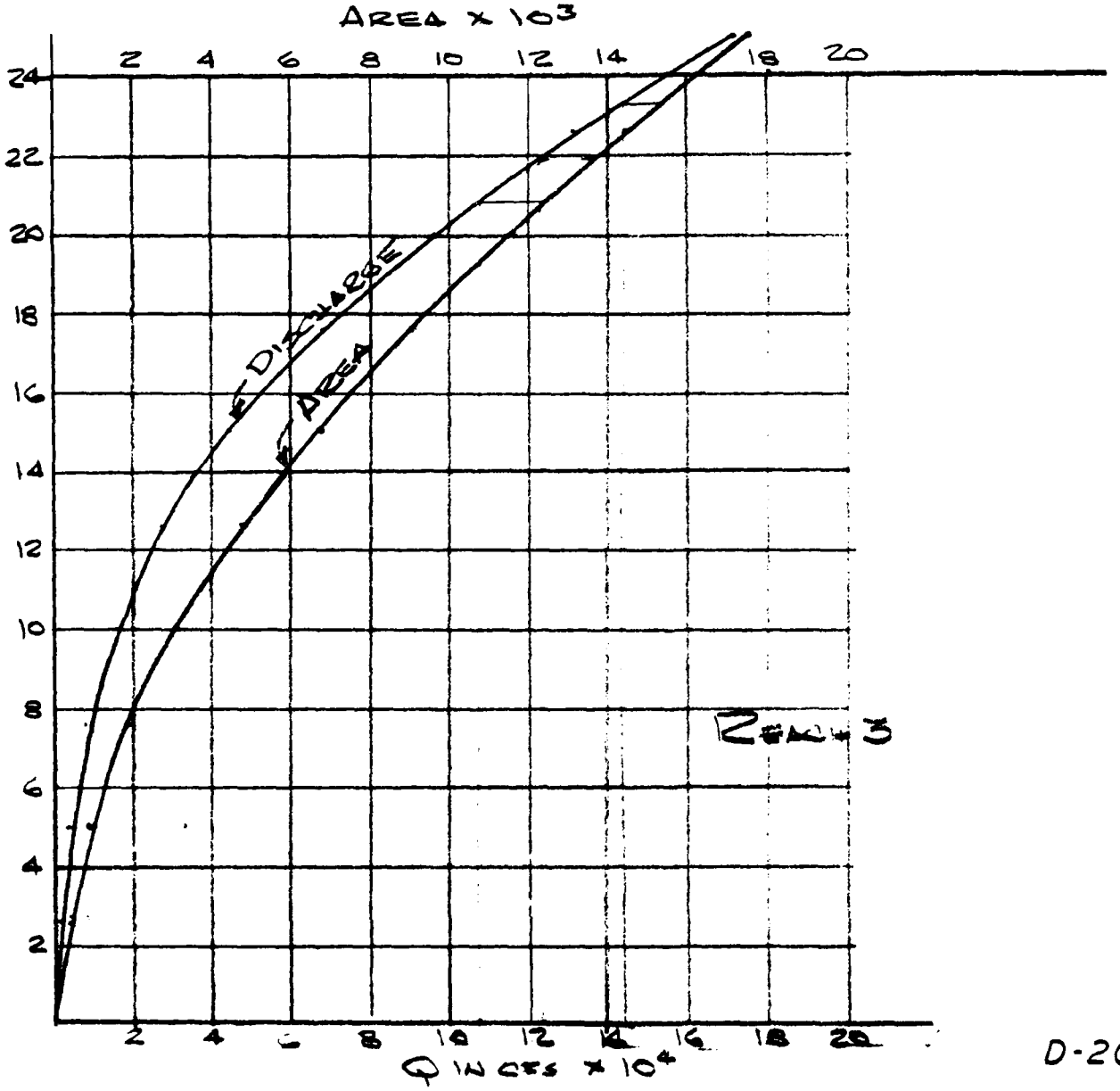


BY RFB DATE 1-13-81 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 6 OF 10

CHKD. BY DATE PROJECT W-198

SUBJECT HOPKINTON RESERVOIR, FAILURE ANALYSIS

STAGE	AREA	P	$R^{2/3}$	Q
2.5	325	180	1.48	820
5	900	280	2.18	3360
7.5	1788	430	2.59	7920
10	3050	580	3.03	15,800
12.5	4688	730	3.46	27,740
15	6700	880	3.87	44,340
17.5	9025	980	4.40	67,900
20	11600	1080	4.87	96,600
22.5	14425	1181	5.31	130,980
25	17500	1381	5.72	171,270



FOR Q = 143,600, STAGE = 23.3, AREA = 15300

$$V_1 = \frac{15300 \times 4800}{43{,}560} = 1686 \text{ AF}$$

$$Q_{P2(TRIAL)} = 143{,}600\left(1 - \frac{1686}{6550}\right)$$

$$= 108{,}250 \text{ CFS}$$

FOR Q = 108,200, STAGE = 20.8, AREA = 12,400

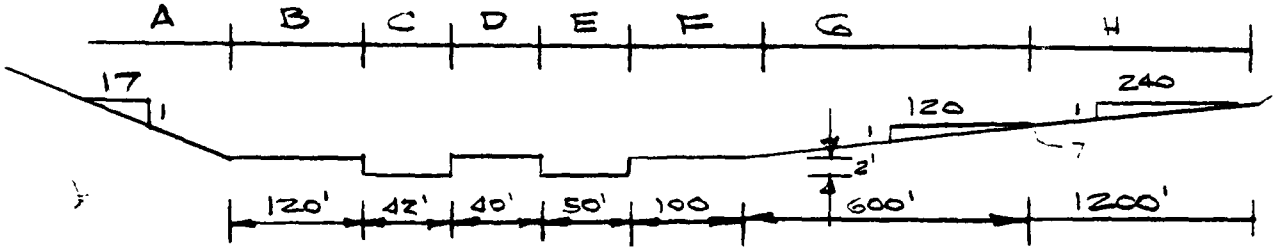
$$V_2 = \frac{12{,}400 \times 4800}{43{,}560} = 1366 \text{ AF}$$

$$Q_{P2} = 143{,}600\left(1 - \frac{1366}{6850}\right)$$

$$Q_{P2} = 115{,}000 \text{ CFS}, \text{ STAGE } 21.3$$

REACH #4, CORDAVILLE RD DAM TO MYRTLE ST. DAM

ASSUME WEIR CONTROLS MYRTLE ST DAM



ASSUME C = 2.5 ALL SECTIONS

	B+D+F		C+E		A			G.		
STAGE	H	Q	H	Q	H	L	Q	H	L	Q
2	0	0	2	650	0	0	0	0		0
4	2	1840	4	1840	1	34	90	1	240	600
6	4	5200	6	3360	2	68	480	2	480	3390
8	6	9550	8	5200	3	102	1320	3.5	600	9820
10	8	14710	10	7270	4	136	2720	5.5	↓	19350
12	10	20550	12	9560	5	170	4750	7.5		30,810
14	12	27020	14	12050	6	204	7500	9.5		43,920
16	14	34050	16	14720	7	238	11020	11.5	↓	58,500

H			TOTAL
H	L	Q	Q
0	~	0	650
0	~	0	4370
0	~	0	12450
0.5	240	210	26,100
1.5	720	3310	47,340
2.5	1200	11,860	77,530
4.5	↓	28,640	119,130
6.5	↓	49,720	168,000

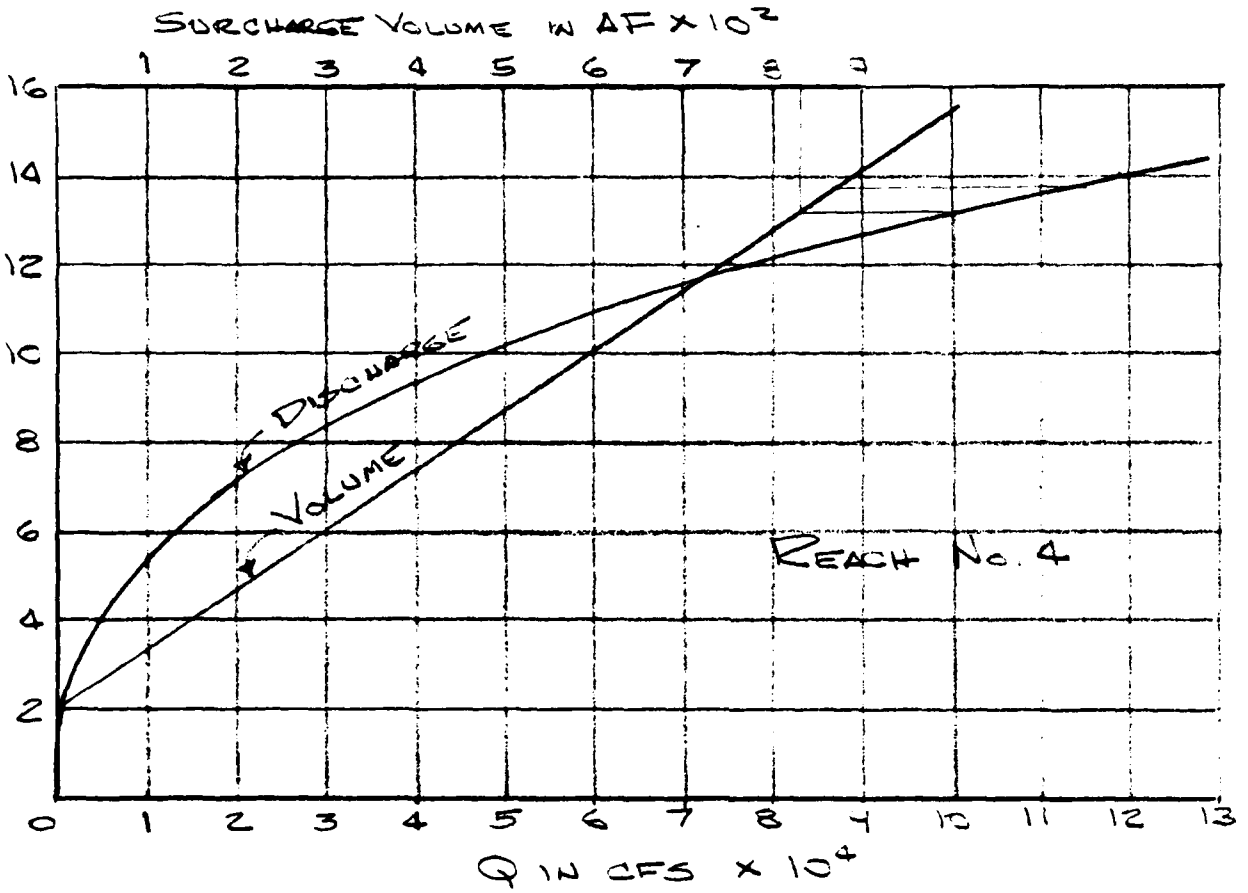
SURCHARGE VOLUME

@ STAGE 2 ∴ AREA = 27 ACRES

@ STAGE 12 ∴ AREA = 123 ACRES

@ STAGE 12

$$\Delta V = \frac{27+123}{2}(10) = 750 \text{ A.F.}$$



FOR Q = 115,000, STAGE = 13.8 FT, VOL = 875

$$Q_{P_2}(\text{TRIAL}) = 115{,}000\left(1 - \frac{875}{6850}\right)$$

$$= 100{,}300 \text{ CFS}$$

FOR Q = 100,300, STAGE = 13.1 FT, VOL = 830

$$\text{AVE VOL} = \frac{875+830}{2} = 852 \text{ AF}$$

$$Q_{P_2} = 115{,}000\left(1 - \frac{852}{6850}\right)$$

$$= 100{,}700$$

SAY Q = 101,000, STAGE = 13.1 FT

SUMMARY OF FLOODING

REACH NO.	NO STRUCTURES	FLOODING DEPTH
1	STATE PARK POOL & BATH HOUSE	LOSS
	HOWE ST	"
	ROSS RD	"
2	1 HOUSE	12 FT
	3 "	6 FT
	1 "	2 FT
	1 INDUSTRIAL BLDG	6 FT
	NY CENTRAL RR.	
	PIPELINE	
3	22 HOUSES	1 TO 8 FT
	5 HOUSES	1 TO 8 FT
	2 COMMERCIAL	1 TO 8 FT
4	65 HOUSES	1 TO 8 FT
	3 COMMERCIAL	1 TO 8 FT

APPROXIMATION BELOW REACH 4 TO RESERVOIR NO 2

60 HOUSES & COMMERCIAL 1 TO 8 FT

TOTAL 163 HOUSES & COMMERCIAL
8 BRIDGES
1 R.R.
1 PIPELINE
1 REC FACILITY
2 DAMS
NUMEROUS ROADWAYS

LOUIS BERGER & ASSOC., IN
WELLESLEY, MASS.
ARCHITECT · ENGINEER

ARMY ENGINEER DIV. NEW ENGLA
CORPS OF ENGINEERS
WALTHAM, MASS.

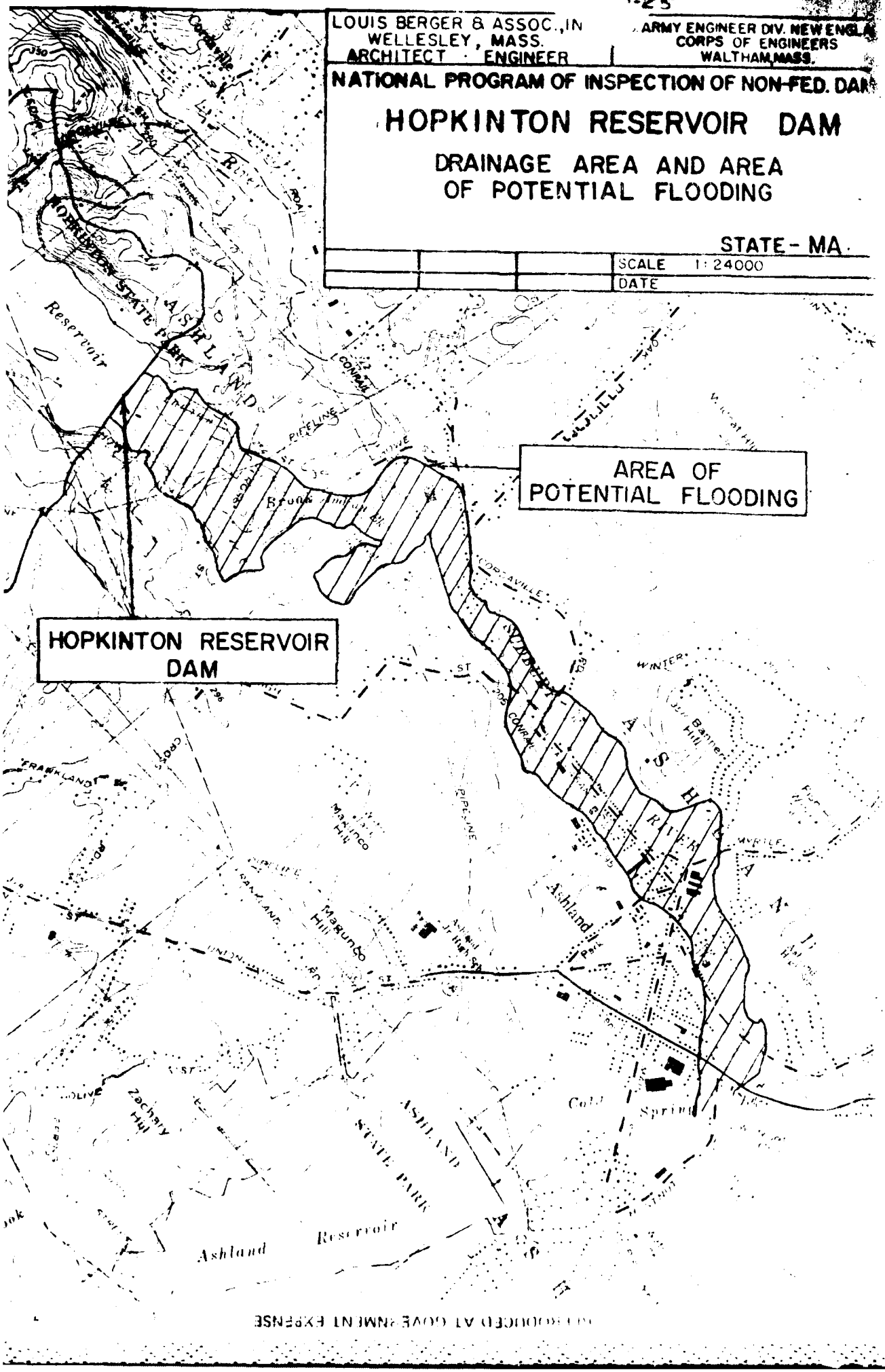
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAM

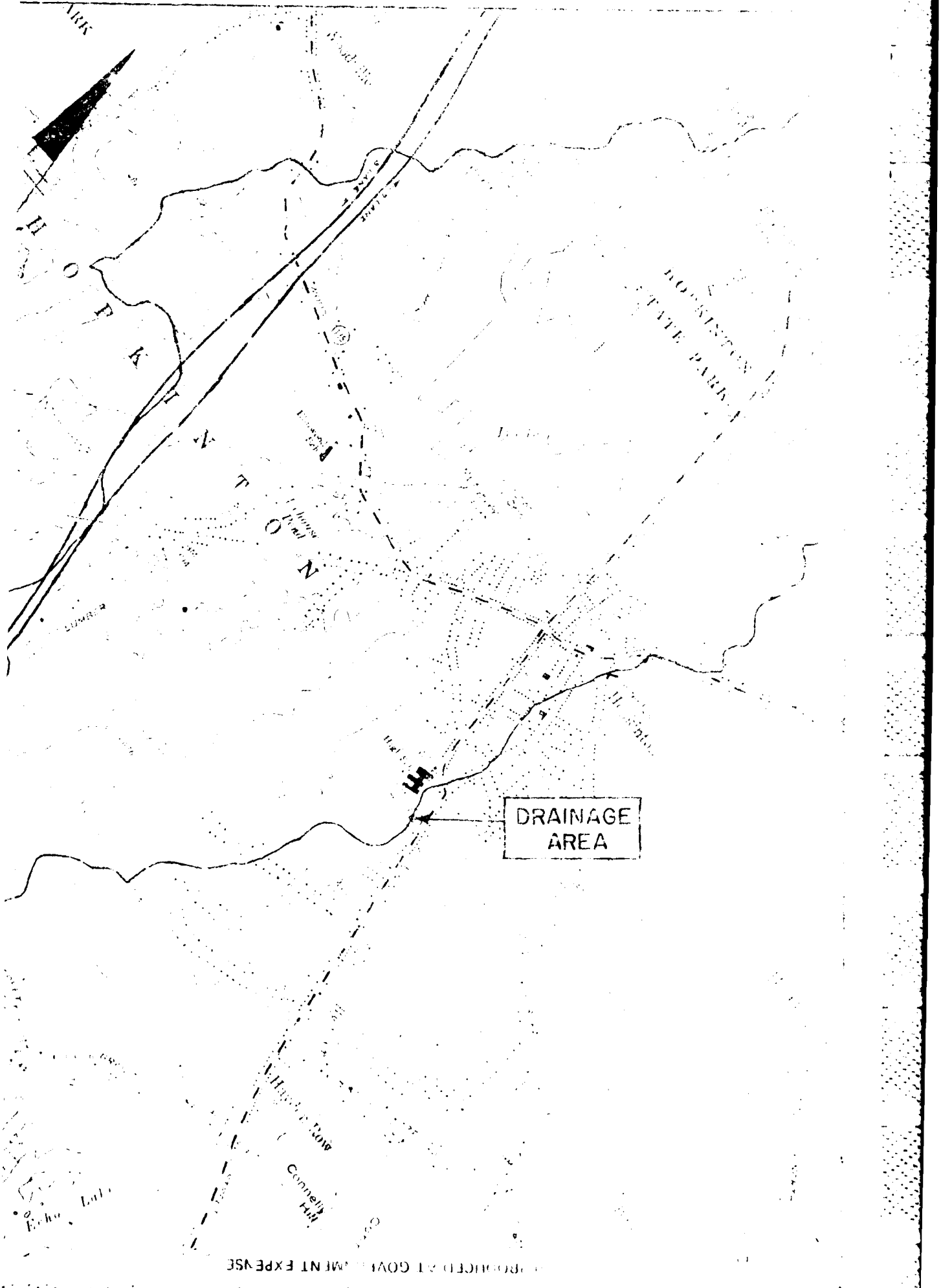
HOPKINTON RESERVOIR DAM

DRAINAGE AREA AND AREA OF POTENTIAL FLOODING

STATE - MA.

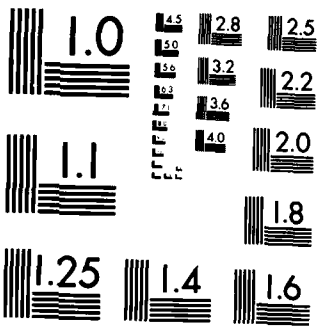
			SCALE 1:24000
			DATE




DRAINAGE
AREA

AD-A154 697 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/2
HOPKINTON RESERVOIR D..(U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV JAN 81

UNCLASSIFIED F/G 13/13 NL



Appendix E

Information as Contained in the National Inventory of Dams

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY | MO | YR
MA	437	NED	MA	017	05				HOPKINTON RESERVOIR DAM	4215.8	7130.7	210CT80

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
	HOPKINTON RESERVOIR

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	06	INDIAN BROOK	ASHLAND	0	8900

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE–FT.)	(27) NORMAL (ACRE–FT.)
REPG	1895	RS	100	58	6400	4500

DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
NED	N	N	N	N	

(28) REMARKS

(29) D/S HAS	(30) SPILLWAY CREST LENGTH	(31) SPILLWAY TYPE	(32) SPILLWAY WIDTH (FT.)	(33) MAXIMUM DISCHARGE (FT.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	(36) POWER CAPACITY PROPOSED (MW)	(37) NAVIGATION LOCKS NO	(38) LENGTH (FT.)	(39) WIDTH (FT.)	(40) LENGTH (FT.)	(41) WIDTH (FT.)	(42) LENGTH (FT.)	(43) WIDTH (FT.)	(44) LENGTH (FT.)	(45) WIDTH (FT.)
1	1525	U	30	1820	331000											

(46) OWNER	(47) ENGINEERING BY	(48) CONSTRUCTION BY
STATE OF MA	UNKNOWN	UNKNOWN

(49) REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

(50) INSPECTION BY	(51) INSPECTION DATE DAY | MO | YR	(52) AUTHORITY FOR INSPECTION
LOUIS BERGER & ASSOC INC	210CT80	PL 92-367

(53) REMARKS

END

FILMED

7-85

DTIC